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AN ACOUSTIC AND SOCIAL DIALECT ANALYSIS OF PERCEPTUAL VARIABLES IN LISTENER IDENTIFICATION AND RATING OF NEGRO SPEAKERS. FINAL REPORT.

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Identifiers-Articulatory Product Score

The purpose of this study was to specify variables which function significantly in the racial identification and speech quality rating of Negro and white speakers by Negro and white listeners. Ninety-one adults served as subjects for the speech task; 86 of these subjects, 43 Negro and 43 white, provided the listener responses. Subjects were chosen to provide a sample approximately representative of the distribution of socioeconomic status scores in the southeastern United States. Listeners were asked to identify the race of each speaker and make a speech quality rating of recorded samples . The Articulatory Product score developed by Guttman was used as an independent, semi-objective index of speech proficiency. In addition, a spectrographic analysis was carried out using a sample consisting of ten Negro male and ten white male subjects. All speakers used in this analysis had been correctly identified by listeners as to race 9 5 percent of the time or better. Results were as follows: (1) The number of phonetic distortions by speakers predicts racial identification. (2) Socioeconomic status score and Articulatory Product score predict speech quality rating of speakers by listeners. (3) No significant intergroup differences were found on spectrographic variables. Negro speakers used in acoustic analysis, however, had consistently greater attenuation of format amplitudes [u] vowel than white speakers. (DO)

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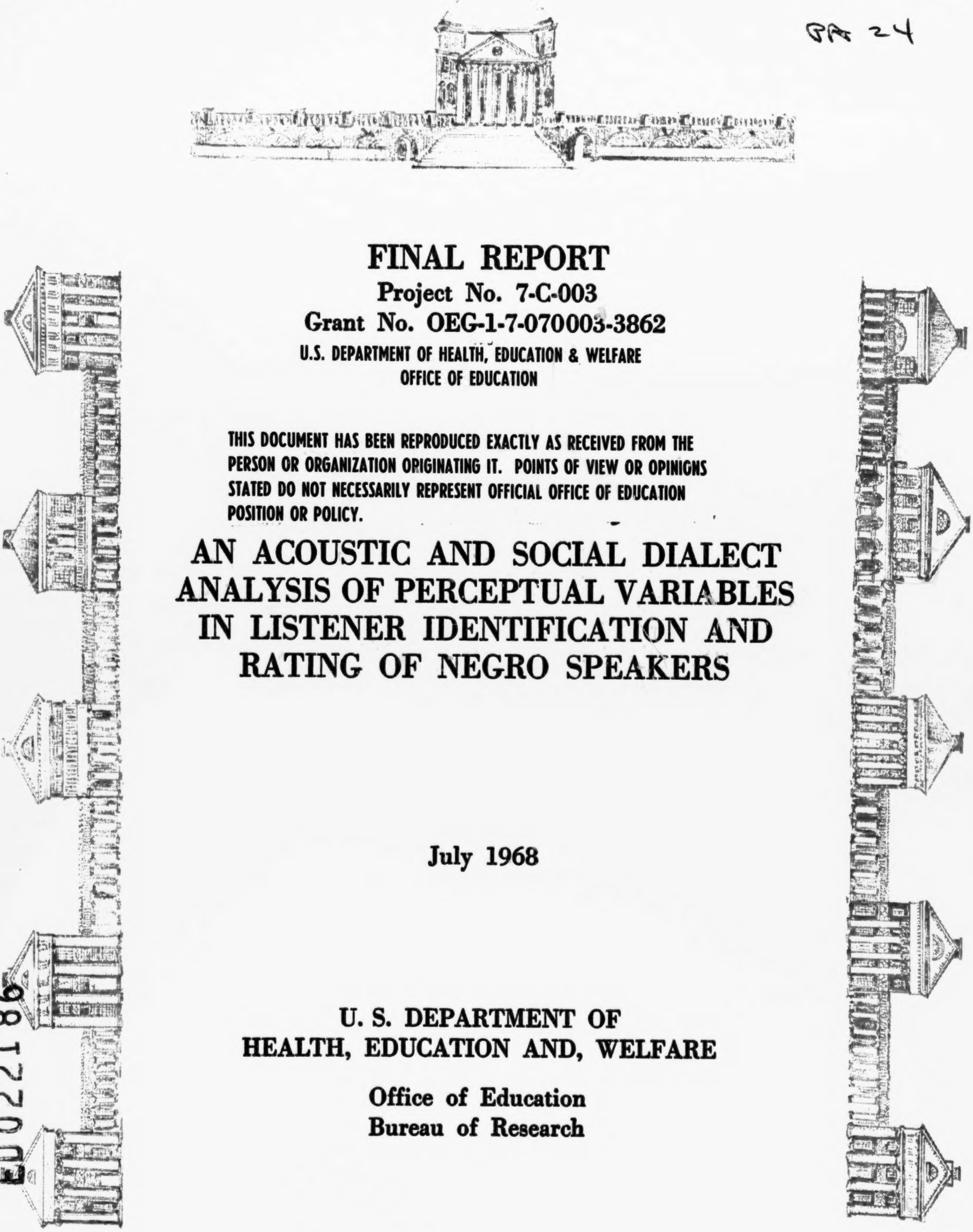

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July 1968

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ABSTRACT

This study used ninety-one subjects in an attempt to specify social and acoustic variables which function significantly in the racial identification and rating of Negro and white speakers by Negro and white listeners. Eighty-six subjects, forty-three white and forty-three Negro, provided the listener responses. Subjects were chosen to provide a sample approximately representative of the distribution of socioeconomic status scores in Southeastern United States.

Listeners were asked to judge the race and overall speech proficiency of speakers from listening to a recorded reading passage. Comparative control was exercised over the quality ratings through use of a semi-objective articulatory product score which provided an independent index of speech proficiency. Additional independent variables included the socioeconomic status score; sex; age; number of articulation errors divided into substitutions, omissions and distortions; number of misarticulated phonemes and a self-rating of speech proficiency. All speaker and listener data were gathered under controlled laboratory conditions. Analysis was carried out through analysis of variance and co-variance using multiple regression technique to determine variables which might be significant in predicting racial identity perception and quality rating of speakers.

A spectrographic analysis was carried out using a sample of the sample consisting of ten Negro male and ten white male subjects. All speakers used in this analysis had been correctly identified by listeners as to race 95% of the time or better.

The purpose of this phase of the study was to specify spectral data in the resonance characteristics of speakers as seen in two selected vowel sounds which might function significantly in listener perception of racial identity and the quality rating of speakers. An intergroup comparison was carried out on the acoustic variables of formant frequency and relative formant amplitude from spectrographic displays of the (i) and (u) vowels.

The results can be summarized as follows:

1. Number of phonetic distortions is significant in predicting listener identification of the race of speakers from recorded speech samples.
2. Socioeconomic status score and articulatory product score are significant factors in predicting speech quality ratings received by Negro and white speakers from Negro and white listeners
3. No significant intergroup differences were found in the comparison carried out on acoustic variables from spectrographic displays. The Negro speakers were found, however, to have consistently lower relative formant frequencies than the white group.

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CHAPTER I

INTRODUCTION

Investigations directed at specification of relationships between man and his environment have occupied a major part of the history of science. Although it has been said that the proper study of man should focus on man himself, it has been realized that the nature of the human organism and its behavior cannot be properly viewed as separate from environmental stimulation and interaction. This consideration has formed the basis of the historic nature-nurture controversy in the study of human development. Studies of the ways in which man responds to and interacts with environmental stimulation have made considerable contribution to human welfare and the accumulated information of the behavioral sciences.

There has been particular interest on the part of scientists interested in human behavior in studies of the sensory-perceptual responses of the human organism to physical stimuli. Such interests in the nature of sensory communication have, according to S. S. Stevens (46), created the hundred-year-old discipline of psychophysics in which the principle concern is with the responses made by organisms to the stimuli of the environment and the specification of these consequences.

The consequences of acoustic stimuli are of particular interest since they constitute a significant portion of the general interactional pattern through which man communicates with his environment. Psychophysics has routinely investigated loudness, pitch, and perceived duration as consequences of relatively simple acoustic stimuli. These investigations have provided the basic information available today on the differential response characteristics of the human organism to sound stimuli. In general, however, according to Voiers (52), the level of information regarding responses of the human auditory system to complex acoustic stimuli such as speech is less precise and cannot be fully specified in terms of elementary attributes of auditory sensation.

The sensory-perceptual consequences of speech signals in man can be viewed and studied in terms of the informational content of such signals. Following the design of classical psychophysical studies, it is possible for investigators in linguistics, psychology, acoustic phonetics and related disciplines to present speech signals in which careful control is maintained over signal characteristics and signal source variables and infer features of the informational content of such signals from observation of subject responses. The literature of these disciplines offers numerous examples demonstrating the broad interest of investigators in the diverse information carried by speech signals in human communication.

Ladefoged (29) has offered a three-part classification of the kinds of information conveyed in speech signals. It is believed that such classification is an important part of the general research effort directed toward the specification of what Peterson (37) has called the "information-bearing elements of speech." Ladefoged says that when we hear a person talking we perceive the linguistic content of his message. This constitutes the class of linguistic features in speech signals which provides the essential linguistic information enabling the listener to know what the speaker has said. In addition to this class, the speech signal may also tell the listener something about the general background of the speaker or provide specific information about the place of origin of the speaker, his group membership and his status within the group. This constitutes the class of group features in speech signals which provides what Ladefoged has designated socio-linguistic information. A third class, idiosyncratic features, provides personal information about the speaker. Such features, according to Ladefoged, may be attributed to anatomical and physical characteristics of the individual speaker such as the shape, size and coupling of resonance cavities of the vocal tract. On the other hand, socio-linguistic information is conveyed by those features of a person's speech which have been acquired through the influence of particular groups in which the speaker is or has been a member. It is possible, Ladefoged concludes, to structure studies designed to specify these classes of informational content either singly or in combination.

The study reported here was designed to contribute psychoacoustic information in the area of sensory-perceptual consequences of speech signals. The personal and sociolinguistic information of such signals was investigated experimentally through the study of variables believed to interact significantly in the identification by listeners of the race of speakers. An attempt was also made to specify acoustic, social, and personal variables which may constitute a basis for the quality judgement of speakers by listeners.

CHAPTER II

STATEMENT OF THE PROBLEM AND BACKGROUND STUDIES

Although numbers of studies have been conducted to specify the informational content of speech, the majority of these have focused on those features believed to provide the essential linguistic information in speech communication. Few experimental studies have been found to focus on idiosyncratic features providing personal information and group features providing socio-linguistic information. Generally, such studies have not included, as part of the experimental design, spectrographic analysis intended to indicate possible acoustic perceptual variables in the information processing carried out by listeners. It was believed desirable that such comprehensive studies be conducted within the disciplinary framework of the speech science laboratory and that they reflect interest in both basic science and the important role of human communication in problems of society.

I. THE PROBLEM

Information content analysis. The problem in informational content analysis formulated for this study was in two areas: (1) specification of those idiosyncratic and group features which provide personal and socio-linguistic information to listeners regarding the racial identity (Negro or Caucasian) of the speaker; and (2) specification of those idiosyncratic and group features which provide personal and socio-linguistic information used by listeners in making overall speaker quality judgements.

Social dialect analysis. Many studies in the area of dialectology have been carried out from the "encoder" point of view. The efforts of Kurath (27) and others in describing the space of dialect geography in the United States and correlating varying speakers pronunciations with particular locations provide a classic example of focus on the encoder in dialect study. In a recent compilation Hymes (21) presents a number of classic papers in this area of research. Other investigators such as Harms (16) and Voiers (52) have stressed the need for such studies to focus upon the differential listener ("decoder") consequences related to the phonological patterns of speech. According to Anisfeld, Bogo, and Lambert (2), listener reaction consequences include such features as differential personality evaluation of the speaker. In their study, listener judgement as to personality characteristics of speakers was found to be significantly dependent upon whether or not the speaker spoke with "pure" or "accented" English. The conclusion was that accented English ". . . aroused certain perceptual hypotheses which had been acquired through previous experience with people who speak English with an accent." (p. 228) Apparently speech differences have been found to arouse certain stereotype reactions in listeners.

These findings were extended in a recent study reported by Markel, Eisler and Reese (32) which was designed to determine whether stereotypic personality judgement reactions take place in oral communication between native speakers of somewhat differing dialects. The results were the same as those obtained in the previous study of reactions between native and non-native speakers. Perceived dialect variation was sufficient to stimulate a stereotypic judgement concerning the personality characteristics of the speaker. These studies have not, however, provided analysis of acoustic, social or personal variables which may function in the stimulation of such judgements.

It has been recognized by Golden (12), and others concerned with social dialect research as it relates to the successful enculturation of minority groups, that stereotypic judgements stimulated by speech differences play an important role in the nature of prejudice and negative reactions in interpersonal relationships. The problem in social dialect analysis formulated for this study concerned an attempt to specify significant factors which may function in inter-racial identification and rating of speakers by listeners. It was believed that such specification would contribute to efforts to provide equal educational, social, and vocational opportunity and general upward mobility to sub-culture groups. In commenting on ethnolinguistic studies in this area, McDavid (34, p. 247) has said:

> In making such investigations, the linguist does not assume that the mere recording of the fact will by itself resolve the tensions; he insists, however, that a framework of fact will be useful to those who seek objective discussion of the problem at issue.

Spectrographic analysis. The acoustic study of speech signals through spectrographic analysis has identified parameters which are believed to be important variables in information conveyed in human oral communication. The typical speech sound spectrogram, as developed in the work of Potter, Kopp and Green (40), provides an instrumentally generated display of the distribution of sound energy in the frequency spectrum across time. An additional representation is possible which displays the relative amplitudes within the spectral energy envelope at any chosen point in time. Important acoustic parameters identified through speech sound spectrography have included resonance regions which are seen as components in the distribution of sound energy in vowel sounds. These resonances are called formants and are thought to represent normal modes of vibration of the cavities of the vocal tract.

Peterson (38, p. 182) has said that, "If the vocal mechanism is considered to be the fundamental information source in speech, then measurements of the acoustical signal which most directly reflect its properties are of primary significance." The spectrographic analysis problem formulated for this study concerned an attempt to specify any significant intergroup differences existing in the spectral characteristics of vowel sounds which may be related to the racial identification and quality judgement of speakers.

II. BACKGROUND STUDIES

Informational content analysis. Investigators in psychology, linguistics, education, and other fields have long believed that speech signals provide basic personal and social status information concerning speakers. Gray and Wise (13, p. 11) have said, for instance, that ". . . much of what we have called personality is found, when it is carefully analyzed, to be resident in the voice."

Many studies have demonstrated the extent to which listeners infer information in speech from the idiosyncratic and personal features described by Ladefoged (29). Although the results of some of these studies are not directly pertinent to the research reported here, they do indicate the range of interest in informational content analysis. H. C. Taylor (48), for instance, reported a study on the extent to which listeners agree on the personality traits of speakers from listening to their voices. Stagner (45) studied the relationship between judgements of voice and personality. Eisenberg and Zalowitz (10) have reported on the extent to which listeners are able to judge dominance-feeling of speakers from phonograph recordings of voices. A recent study by Ptacek and Sander (41) demonstrated that listeners are able to make accurate gross identification of the age of speakers under a variety of listening conditions.

A series of studies carried out by Harms attempted to investigate the information carried in speech signals relative to the social status of speakers. The most recent (18) report concluded that the signal apparently carries valid informational content on the social status of the speaker. A high correlation was found between listener judgements of socioeconomic status and objectively obtained status scores. In an earlier study (17), listeners from different social status groups heard short recorded messages from speakers of different social statuses. After listening, the respondent attempted to replace words which had been systematically deleted from a written version of the messages. Based upon degree to which listeners were able to replace the deleted words, speakers of high status were found to be the most comprehensible. The same criteria also indicated that listeners were most successful in comprehension when responding to speakers of their own status rating. In an additional study more directly related to the problems posed in this research, Harms (16) found that listeners from different social strata were capable of rating the social status of an individual after hearing ten to fifteen seconds of his tape recorded speech. Listeners also rated the high-status speakers as more credible than low-status speakers. While these studies make an excellent contribution, it can be noted that apparently speakers of differing status groups were treated categorically on the matter of speech proficiency. There was also no reported attempt to differentiate the function of acoustic variables in the speech signals.

Several recent studies of the informational content of speech signals have focused on the basis of speaker recognition and identification by listeners. Holmgren (19) attempted to specify some of the physical and psychological correlates of speaker recognition and concluded that listeners can differentiate reliably among speakers on the basis of judged voice characteristics.

The aim of the previously cited study by Voiers (52) was to identify the information bearing elements in complex speech signals which are available and used by listeners in making identification judgements of speakers. A secondary aim was to specify what the author calls "extrastimulus factors" operative in the perceptual responses of listeners to voice stimuli. Such factors include listener biases and idiosyncratic listener errors based upon particular kinds of listener-speaker interaction which cannot be solely specified in terms of acoustic constituents of the input signal. Presumably, this would include listener preparatory perceptual sets based upon personal feelings and past history.

A study reported by Dickens and Sawyer (7) in Southeastern United States in 1952 was directed at problems similar to those posed in this study. The results have implications both in the area of informational content and social dialect analysis. The authors were interested in investigating perceived differences in vocal quality using Negro and white speakers and listeners. In contrast with the research reported here, however, the Dickens and Sawyer study did not consider social or educational variables or attempt to compare perceived speaker quality with speaker quality determinations obtained through more objective means. Since vocal quality was considered to be solely a quality of listener perception rather than a physical property of sound, no attempt was made to correlate listener judgements with acoustic features of the speech signal. Twenty college students served as speaker subjects and members of college public speaking classes served as judges.

Although the research population and number of variables was quite distinct from that of the present study, some of the results may provide useful comparison. The authors found, for example, that there was approximately seventy per cent correct identification of the race of the speakers; that the white observers were more accurate in racial identification than the Negro observers; and that there was significantly greater accuracy shown by observers in identifying speakers of their own race. Additional findings indicated greater accuracy in identifying the race of male speaker. The combined judgement of all listeners rated Negro females and white males as highest in vocal quality. Of particular interest was the finding that racial bias in quality rating was of low statistical significance and that the amount of bias that was present favored voices of the other race. No explanation was offered for this latter result.

It is apparent that considerable research effort has been invested in systematic study of idiosyncratic and group features which convey personal and sociolinguistic information in speech signals. None of the investigations reviewed, however, carried out an analysis of a broad range of social, educational, economic, acoustic and vocal quality variables constituting specific informational content of speech signals used by listeners in perception of speaker racial identity and vocal quality.

Social dialect analysis. There is considerable current interest on the part of educators, social psychologists, sociologists, linguists, and others in the effect of speech and language differences on the educational, vocational and psychological welfare of children and adults of ethnic minorities. This interest has grown as society has experienced problems associated with increased social, educational, and economic desegregation. Research studies and educational program related to these socio-cultural changes have focused particular attention on the language and phonological factors of human communication. It is generally believed that these are important factors to be considered in efforts to bring about full participation by members of isolated minority groups in the educational and vocational opportunities of society.

This importance has been further emphasized in recent work of this investigator and the Department of Speech Pathology and Audiology, University of Virginia in programs supported by Title IV of the Civil Rights Act of 1964. In 1965-1966 the Charlottesville, Virginia City Schools received Grant Number OE-6-36-56-008 under this Act to develop programs to counteract certain problems which were believed to be associated with continued racial desegregation. One of these problems involved complaints about the speech patterns of Negro teachers in newly integrated faculties and schools. At the request of the Superintendent of Schools, a special non-credit academic program was designed by this investigator within the Department of Speech Pathology and Audiology, University of Virginia to answer the needs of individual teachers and the School Division. It is hoped that the findings reported here will provide information basic to the solution of such problems and to the continued function of educators and speech scientists in facilitating socio-cultural changes in society.

Interest in the effect of speech differences on opportunities available to minority group members has been expressed by many and this interest has stimulated increased research in the area of socio-linguistics. According to Green (14), the non-standard speech of the majority of American Negroes can be seen as the major obstacle to successful entrance into a predominantly white world. Francis (11) has noted, in work being conducted by Northern universities in traditionally Negro colleges, that Negro students speak a dialect considered by some to be socially inferior. The application by linguists and speech scientists of various methods of social dialect analysis to this problem has resulted in much recent and continuing research.

An extensive analysis of dialect related barriers to communication was recently reported by McDavid, et al. (33) from the Chicago, Illinois area. In the section of the study conducted by Larson and Larson (31) on listener reactions to pronunciation it was found that the pronunciation patterns of Negroes were generally rated as more unpleasant, less educated, and less urban than white pronunications. Listeners tended to favor white pronunciations and were able to distinguish between white and Negro speakers even when the pronunciations were very similar. A finding of particular interest was that Negro judges tended to agree with white judges. The authors interpret this to mean that many Negroes may implicitly accept the white standard of pronunciation as more valuable. This finding is in contrast to that reported by Dickens and Sawyer (7) in the study cited previously.

The McDavid, _et al._, (33) study may be partially supported by social dialect studies conducted by Labov, Cohen and Robins (28) in the New York City area. These investigators reported that there may be an unconcious conflict of values in the speaker of a non-standard dialect. It is stated (p. 23) that:

> . . . it is possible for a lower-class speaker to participate in the full sociolinguistic structure of a speech community, and possess a good knowledge of the norms of careful speech, yet be unable or unwilling to use these forms in speech or writing.

Linguists conducting social dialect studies appear to be in increasing agreement on the existence of a Negro dialect as a legitimate dialect of English. Some believe that certain features of the pattern may transcend traditional dialect geography boundaries. In the Labov, et al. (28) study, for instance, it is stated (p. 23) that:

> The grammatical patterns underlying deviations from standard English for Negro subjects of the Lower East Side are not characteristic of a particular local or regional dialect, but have been found in Harlem, Chicago, Cleveland, Philadelphia, Boston and South Carolina, also.

Studies conducted by Harlan Lane and associates (30) of the Center for Research in Language and Language Behavior, University of Michigan have concluded (p. 20) that:

> Recent linguistic research has shown that the speech patterns of southern Negroes constitute a legitimate dialect of English with grammatical (including phonological) rules somewhat different from General American English (GAE).

Some of their reported research has been directed at determining whether the distinguishing characteristics of Negro dialect lead to differences in the ways in which Negroes perceive speech. It was found that speakers of Southern Negro dialect are not as accurate as Caucasians of the same geographic and socioeconomic background in correctly perceiving General American English. This finding was supported in a earlier study by Caroline (5) in which it was found that there are statistically significant differences in intelligibility scores between the white and Negro students.

The effect of these dialect related speech and language differences on communication and learning ability in educational settings is being considered by Weener (54). Some educators have been concerned about the possible problem of communication in classrooms in which there is dialect disparity between the teacher and the pupil. Weener is currently engaged in research directed at specification of the effects of dialect differences between teachers and pupils on the immediate recall of verbal messages.

Hurst (20) has investigated the psychological and sociological correlates of dialect difference and has used the term "dialectolalia" to refer to dialect related speech differences which are so non-standard that they have a potentially negative effect on the psychological, educational, and vocational welfare of the individual. He has referred to the work of Anisfeld (1) who found that listeners tend to be influenced negatively by stereotypes which are reinforced by the speech patterns of speakers. In an interesting study conducted by Stroud (47) and cited by Hurst it was found that judges were able to discriminate between recorded voices of Negro and white students in ninety-three per cent of the cases. It was also found that, as socioeconomic status went up, there was a reduction in identification errors.

A study conducted by Edmonds (9) has provided some information on the function of socioeconomic and sex differences in verbal ability among Southern Negro high school students. Socioeconomic status was found to have a greater relationship to verbal ability than the sex of the speaker. This study showed no significant differences between the verbal abilities of males and females within the deprived group.

The only study found to focus on phonological analysis was that reported to be currently in progress by Shuy (44). An interim report has stated that (p. 73) the research is attempting to carry out a "contextual phonological analysis" to investigate "hypotheses concerning phonological correlates of stratification . . ." The investigator is particularly interested in the presence, absence and substitution of nasal components and the ways in which these factors may relate to the social level of the speaker.

In 1952 Currie (6) made a strong plea for consciously directed research in the area designated socio-linguistics. Although much has been done and impetus provided by changing social patterns and emerging social problems has greatly stimulated the activities of linguists and speech scientists, there are numbers of unresolved questions regarding the interrelationship of significant speaker and listener variables and specific analysis of intergroup and intragroup acoustic differences.

None of the studies reviewed have reported a systematic specification of the educational, vocational, socioeconomic, and acoustic variables which function in the listener identification of the Negro speaker as a Negro speaker. There has been a particular lack of attempt to measure and differentiate the function of levels of objectively determined speech proficiency among Negro speakers which relate to identification and rating by listeners. Is there a point, for instance, on a scale of speaker proficiency at which stereotypic, negative reactions of listeners are seen to change? None of the studies reviewed have considered a broad range of listener as well as speaker variables which may be significant in the perception of racial identity and quality judgement. No studies have been found which have extended acoustic analysis to a comparative spectrographic investigation on speakers who have been consistently identified as to race by both Negro and white listeners.

Spectrographic analysis. A preliminary investigation conducted in the Speech Science Laboratory of the University of Virginia was pertinent to the currently reported research. The results of the preliminary study indicated the possible efficacy of research designed to specify variables in listener identification and rating of speakers which may be a function of the distribution of acoustic energy within the speech spectrum.

The study, The Effect of Signal Bandwidth Compression on Listener Perception of Racial Identification by Bryden (4), used spectral filtering in which the speech signal was compressed to a 500 Hz bandpass between 1250 Hz and 1750 Hz. Although frequency distortion procedures in which the bandwidth is compressed or interrupted through electrical filtering are most often carried out for the purpose of determining the effect on signal intelligibility, this study employed controlled distortion technique to determine only the perceptual effect on whatever information bearing elements there may be in the speech signal which provide significant listener cues regarding the racial identity of the speaker.

A sample of twenty speakers, ten white and ten Negro, was recorded using a standard reading passage. Two experimental tape recordings were prepared with the same speakers appearing in different randomly determined order. One of the tapes was subjected to controlled signal bandwidth compression procedures. The null hypothesis stated for the study was that such procedures would not significantly effect listener ability to make correct identifications of the race of the speakers. It was speculated that it might be necessary to accept the null since it was generally believed that informational cues for racial identity would not be a function of spectral energy distribution but rather a matter of stress related to vocal effort.

A group of twenty listeners, ten white and ten Negro, listened to the two tapes and attempted to record a correct identification of the race of each speaker. A forced choice condition was used. Responses were scored on the basis of percentage of correct judgement. The mean correct listener response on the unfiltered tape was seventy-four per cent. The listener response to the filtered tape produced lower scores with a mean difference of 6.25. This difference was significant at the .01 level of confidence indicating that the spectral filtering significantly disturbed the listener's ability to make correct judgements of the race of the speakers. The null hypothesis was rejected.

It was apparent from this preliminary study that there may be important informational cues for the racial identification of speakers by listeners which were removed through the application of controlled signal distortion technique. The creation of the 500 Hz bandpass between 1250 Hz and 1750 Hz was sufficient to alter the perceptual ability of listeners even though a number of the listeners reported that they consciously focused their perceptual set on certain non-segmental elements such as vowel distortion and prosody.

The pilot study suggested that further research might be conducted to investigate the extent to which listeners are able to make auditory perceptual judgements about the racial identity of speakers and the significant listener and speaker variables associated with these judgements. It was believed that a comparative analysis might identify inter-speaker acoustic differences which function in such identification.

The question of whether there may be intrinsic physical differences in the dimensions of the vocal tract which would be reflected in the arrangement of the harmonic components of the speech signal and which might account for what has come to be identified as Negro dialect, was raised by Claude M. Wise (55) in an article published in 1933. Wise said (p. 523) at that time:

> . . . the characteristic Negro vocal quality seems to result from a tongue position which may possibly be a heritage from the original African speech.

Wise goes on to say (p. 523) that:

> This quality surely cannot result from any peculiar physical formation of Negro resonance cavities, for northern Negroes, reared among a majority of whites, have nothing of this Negro voice quality.

Apparently, it was believed that the "tongue position" was a learned behavior, which was a part of the cultural-linguistic history of the American Negro rather than a reflection of intrinsic physical differences.

The spectrographic analysis reported in this study compared the speech of a group of male speakers consistently identified by listeners (Negro and white) as being Negro speakers and the speech of a group of male speakers consistently identified by listeners

(Negro and white) as being white speakers. The speech samples were analyzed by measurement of the variables of vowel formant frequencies and relative vowel formant amplitudes and intergroup comparison was conducted in an attempt to specify significant differences.

According to a recent study reported by Dixon (8), such measurements are usually made from amplitude sections of vowel sounds using the narrow band filter on a sound spectrograph to resolve the individual harmonics (24,25). From such displays it is possible to determine the location of formants on the frequency scale and make measurements of the relative amplitudes of the formant frequency peaks. Although there has been some controversy concerning the best method of determining formant frequency location, Peterson (39) has concluded that, in the light of present knowledge, it is reasonable to define the formant frequency as the frequency of the harmonic with the greatest amplitude peak. There is general agreement, according to Dixon (8), that the relative intensity of formants is determined by measuring the number of decibels from the peak of one formant to the peak of another.

Since the spectrographic analysis reported here involved specification of mean differences in intergroup comparison, rather than a descriptive specification, it is not considered necessary to detail the many studies in acoustic phonetics which have been concerned with attempted descriptions of invariance in speech perception. A search of the literature failed to reveal any previous studies is which speech sound spectrography has been used for intergroup comparison in social dialect analysis.

III. QUESTIONS

Experimental treatment of the problems discussed previously in informational content analysis, social dialect analysis and spectrographic analysis was designed to answer the following questions:

1. What is the function of the actual race of speakers and the actual race of listeners in the racial identity of speakers perceived by listeners on the basis of acoustic information?
2. What is the function of the sex of speakers and the sex of listeners in perception of racial identity?

3. What is the function of the socioeconomic status of speakers and of listeners in perception of racial identity?

4. What is the function of such speaker and listener proficiency indicators as semi-objective articulatory product score, number of articulation errors and number of misarticulated phonemes in perception of racial identity?

5. What is the function of speaker and listener self-rating of speech proficiency in perception of racial identity?

6. What is the function of the overall perceived race of speakers in quality rating of speakers by listeners?

7. What is the function of the race of listeners in overall quality rating of Negro and Caucasian speakers?

8. What is the function of the sex of speakers and of listeners in overall quality rating of Negro and Caucasian speakers?

9. What is the function of the socioeconomic status of speakers and of listeners in overall quality rating of Negro and Caucasian speakers?

10. What is the function of such speaker and listener proficiency indicators as semi-objective articulatory product score, number of articulation errors and number of misarticulated phonemes in overall quality rating of Negro and Caucasian speakers?

11. What is the function of speaker and listener self-rating of speech proficiency in overall quality rating of Negro and Caucasian speakers?

12. Are there significant mean differences on selected acoustic variables between a group of speakers consistently judged by listeners to be Caucasian and a group of speakers consistently judged by listeners to be Negro?

The experimental design and procedures developed to pursue these questions are described in the next chapter.

CHAPTER III

PROCEDURES AND PERFORMANCE OF SUBJECTS

The experimental design and procedures developed to answer the questions listed previously can be conveniently viewed in two sections: (1) an analysis of the function in racial identification and rating of speakers by listeners of such listener and speaker variables as race, sex, socioeconomic status, measured speech proficiency and self-rating of speech proficiency, and (2) a comparison of speakers perceived by listeners to be Negro with speakers perceived by listeners to be Caucasian on such spectrographically displayed acoustic variables as vowel formant frequencies and relative vowel formant amplitudes. This latter section was designed to use a sample of the original sample in an attempt to identify spectral variables which may function significantly in the racial identification of speakers by listeners.

Although evidence presented by Labov (28) would place little restriction on the extent of generalization possible from studies of Negro dialect, the population specifically designated for this study was Area 15 of the _Linguistic Atlas of the Eastern United States_ (27). The sample was drawn from the City of Charlottesville and surrounding counties. This area is in the approximate geographic center of Area 15 which includes most of central and Eastern Virginia, and large sections of Maryland and North Carolina. According to reports published by the Bureau of Population and Economic Research, University of Virginia (49,50), the Charlottesville-Albemarle area has a total population of 74,766 and a per capita income level of $2,368.00 per year. The presence of the University of Virginia, widely diversified light and heavy industry and the usual laboring occupational classes provide access to a wide distribution of socioeconomic and educational achievement levels in both Negro and Caucasian population groups.

I. EXPERIMENTAL DESIGN

A. ANALYSIS OF THE FUNCTION OF LISTENER AND SPEAKER VARIABLES IN RACIAL IDENTIFICATION AND RATING OF SPEAKERS

Listener Response Data

1. Listener identification of the race of the speaker (Caucasian or Negro)
2. Quality rating of speakers by listeners (good speaker - average speaker - poor speaker)

Data Collected on Subjects Used as Speakers and Listeners

1. Social and personal
    - a) Race
    - b) Sex
    - c) Socioeconomic status score representing:
        - (1) Occupation
        - (2) Educational level
        - (3) Family income
2. Non-spectral acoustic
    - a) Articulatory product score representing:
        - (1) Speaking time duration
        - (2) Number of misarticulated words
    - b) Total number of articulation errors representing:
        - (1) Number of distortions
        - (2) Number of omissions
        - (3) Number of substitutions

c) Total number of misarticulated phonemes

d) Self-rating of speech proficiency (good speaker-average speaker-poor speaker)

B. INTERGROUP COMPARISON OF SPEAKERS

A sample of the sample used for the previous analysis was drawn at random from a pool consisting of male speakers who had been consistently identified as being Negro speakers and male speakers who had been consistently identified as being Caucasian speakers. This procedure produced two groups of speakers: (1) ten male speakers who had been correctly identified by listeners 95% or better as being Negro speakers and, (2) ten male speakers who had been correctly identified by listeners 95% or better as being white speakers. Intergroup comparison of means was carried out on the following spectrographic variables to identify significant differences. Rationale for selection of the vowels to be studied is discussed in the section on spectrographic procedures:

1. Formant frequencies on (u) and (i)
    a) Mean F_1 frequency
    b) Mean F_2 frequency
    c) Mean F_3 frequency

2. Relative formant amplitudes on (u) and (i)
   (Reference point = F_1 peak)
   a) Mean F_1 - F_2 (Difference)
   b) Mean F_2 - F_3 (Difference)
   c) Mean F_1 - F_3 (Difference)

II. PROCEDURES

Sampling procedures. Subjects were chosen at random within socioeconomic status categories representing the population of Southern United States (51). Population sources for sampling included senior high school students, university students and job applicants at the Virginia State Employment Bureau. The following criteria was adopted in selection of subjects for this study:

A. Age. Subjects were adults between the ages of 17 and 65. The lack of significant variability in vocal pitch levels of adults between these ages has been supported by research reviewed and reported McGlone and Hollien (35).

B. Sex. The sample contained both male and female subjects.

C. Race. The sample contained an approximately equal number of Negro and Caucasian subjects.

D. Socioeconomic status. Subjects were selected to provide both Negro and Caucasian representation from low, middle and high status levels.

E. Hearing. Subjects had normal hearing in both ears as determined by pure tone and audiometric screening using a frequency sweep at 25 dB (ISO). Rejection criteria was failure to hear one or more frequency in either ear.

F. Speech. Subjects were free from gross organic pathologies of speech such as cerebral palsy, cleft palate and cerebrovascular trauma (determined by interview).

G. Reading ability. Subjects were literate as determined by ability to read the test passage with no problem in word recognition apparent after two practice trials. (determined by interview).

H. General Health. Subjects were free from any extreme oral, nasal or pharyngeal congestion (determined by interview).

I. Linguistic geographic background. Subjects were lifetime residents of Area 15 as described above (determined by interview).

J. Speech training. Subjects had no formal speech training beyond a high school or college public speaking or voice and diction course.

Sample description. Table 1 indicates that a total of 91 subjects participated in this study. With the exception of five who did not return, all subjects served as both speakers and listeners. The sample of listeners providing the response data referred to in the experimental design contained 43 Negro and 43 white subjects.

TABLE 1

NUMBER OF NEGRO AND WHITE SUBJECTS USED AS SPEAKERS AND LISTENERS

Type of Subject	Race Negro	 White	Total
Speaker	47	44	91
Listener	43	43	86

Table 2 describes the mean age and age range of the subjects and Table 3 offers a description of the sex of the subjects by race.

TABLE 2

MEAN AGE AND AGE RANGE OF SUBJECTS

Race of Subjects	Mean Age	Range
Negro	30	17 - 59
White	21	17 - 29
All Subjects	25	17 - 59

TABLE 3

SEX OF SUBJECTS

Race of Subjects	Sex		Total
	Male	Female	
Negro	26	21	47
White	31	13	44
All Subjects	57	34	91

Table 4 indicates the means and ranges of socioeconomic status scores calculated for Negro and white subjects. Although considerable disparity can be noted between the mean score for Negro subjects and the mean score for white subjects, Table 5 illustrates the extent to which this difference reflects the percentage distribution of such scores in the population of Southern United States. The greatest problem in sample stratification on

TABLE 4

SOCIOECONOMIC STATUS SCORES OF SUBJECTS

Race of Subjects	Mean SES Score (51)	Range
Negro	43.34	9 - 98
White	60.78	13 - 99
All Subjects	51.78	9 - 99

TABLE 5

PERCENTAGE DISTRIBUTION OF SOCIOECONOMIC STATUS SCORES IN THE SAMPLE AND IN THE POPULATION OF SOUTHERN UNITED STATES

Score Categories (Range=0-100)	Percent in Population (51)	Number in Sample	Percent in Sample
	Distribution of Negroes		
80 - 99	1.60	10	21.27
50 - 79	8.10	4	8.51
20 - 49	41.80	23	48.93
0 - 19	48.50	10	21.27
	Distribution of Whites		
80 - 99	12.10	9	20.45
50 - 79	36.60	18	40.90
20 - 49	37.00	15	34.09
0 - 19	14.20	2	4.54

the socioeconomic status variable was matching the sample to the population at the extreme ends of the scale. It will be noted that, although reasonable close matching exists in the middle categories, there is some disparity at the extremes of the scale. Consideration was given to dropping a number of subjects from the upper socioeconomic category of each subject group. This was not done, however, as the upper groups were found to be homogeneous on the experimental variables. It was not believed, therefore, that the numerical weighting of this group would significantly effect the analysis. In addition, it was felt desirable that sample size be kept as large as possible.

Interviewing procedures. Subjects were interviewed by the Investigator or the Research Assistant. Items in the criteria listed previously were checked to determine eligibility and information for the Questionnaire Form was requested from each subject (see Appendix A). The information item regarding "race" did not appear on the Questionnaire Form but was coded by the interviewer as part of the eligibility checklist which appeared in a box in the upper right hand corner of the form. The form was constructed to provide all information necessary for the personal and social variables.

Subjects were told that we were collecting samples of the voices of many speakers to check on the quality of our tape recording. Each subject was assigned a number taken at random from tables. The number appeared on the Questionnaire Form, the data form and as a spoken record on the subsequent tape recording. At the end of the interview subjects were given a hearing screening test and a copy of the test passage. They were asked to read the test passage over silently and ask about any unfamiliar words. They were then asked to read the passage out loud once for practice.

The test passage. The test passage adopted for this study was the one offered by Guttman (15) to accompany the Articulatory Product formula. This formula will be discussed in detail in a later section dealing with the recording of data. The test passage is as follows (p. 325):

> Many people want to have relatively heavy breakfasts that include a rich sweet such as cake. Others purposely restrict themselves to a glass of orange juice. Some frequently go without a morning meal. Do those who eat lightly lunch early?

Guttman has stated (p. 325) the following criteria for the development of the test passage and has pointed out the findings of Morrison (36), Sherman and Morrison (43), and Sherman and Cullinan (42) that specimens of speech at least as short as ten seconds can be rated reliably:

> (1) Words of uncertain syllabic number (e.g., "general") should be avoided; (2) words of uncertain word count (e.g., "anyone") should be avoided; (3) "and" and "the" should be avoided (since they suffer severe reduction); (4) nearly all General American English phonemes should be represented, and higher than typical representation should be given to frequently mispronounced ones (l/, r, s/); (5) the last sentence should be a question (to try to prevent a reduction of effort); (6) slightly troublesome phonemic sequences should be included; (7) phonetic density should be slightly above average.

Each speaker identified himself on the test tape by first speaking his assigned number in the phrase, "I am speaker number ____________." In addition to the test passage, each speaker read the sentences, "I will say beet," and "I will say boot." These sentences provided speech material similar to that used by Dixon (8) for spectrographic analysis.

Tape recording procedures. Stereophonic recording of subjects took place in the double room side of an Industrial Acoustics Corporation Model 1603-ACT two-room, sound isolated auditory test suite. Each subject was seated with his head positioned eight inches from two Sony F-121 dynamic microphones. A Sony TC-777-4 tape recorder was located in the other room of the test suite and was positioned so that the operator could view the subject through the connecting window. The test material (test passage and sentences) was printed in large type together with instructions and positioned for easy reading on a stand. The material was printed on the cards following a procedure described by Markel (32) to control for pauses. Each line of the copy read by the speaker either ended with a punctuation mark or with a natural grammatical pause.

Subjects were asked to maintain their head position in relation to the microphones and to begin reading as soon as they saw a red light come on which was positioned in the observation window of the two-room suite. Subjects were asked to read all of the test material two times to provide further practice and a stable recording level. During the first reading the operator adjusted the record levels on the two channels of the Sony 777-4 so that both V.U. meters peaked at approximately one hundred per cent with only occasional transient peaks above this level. The second complete reading of the material was recorded. It is believed that the number of practice readings helped to eliminate any reading difficulties and provided an additional check on subject eligibility. Recording was on new Scotch "Dynarange" (201-12) high quality recording tape at a speed of 7 1/2 inches per second. Auditory monitoring using a Sony DR-3C headset and visual monitoring using the V.U. meters was maintained during the recording.

Recording of data. A speaker data form was used for recording the personal and socioeconomic data from the Questionnaire Form and the acoustic data from the taped speech samples:

(1) Calculation of socioeconomic status score. The socioeconomic status score was calculated using a method developed by the Bureau of the Census, United States Department of Commerce. The score is the simple average of three numerical weights assigned to the occupation, educational level and the total family income for

the chief income recipient in the family. Weighting scores for the categories of occupation, educational level and family income are given in the report provided by the Bureau of the Census (51).

(2) Calculation of the articulatory product score. The articulatory product score is a semi-objective score developed and standardized by Guttman (15) at the Bell Telephone Laboratories. It represents overall merit of articulatory performance and is believed by Guttman to contain those factors which listeners use to make global judgements of speaker quality. Calculation of the score uses the variables of whole word articulatory accuracy, total number of words in the test passage, optimal speaking duration on the test passage and actual speaking duration. The values representing these variables are used in the following formula which calculates the articulatory product (AP):

$$AP = W/W_o \times T/T_o \quad \text{when } T \text{ is less than or equal to } T_o \text{ or}$$

$$AP = W/W_o \times T_o/T \quad \text{when } T \text{ is greater than } T_o$$

where W_o is the total number of words in the test passage, W is the number of correctly articulated words, T_o is the optimum speaking time for the test passage, and T is the measured speaking time on the test passage. In summarizing the standardization study, Guttman (p. 338) says:

> The Articulatory Product correlates highly with subjective estimates of speech merit. It may be used by a single scorer rather than a panel of trained judges, is quantitative, provides a means of rapid evaluation, and does not require explicit analysis of articulation.

The AP score for each speaker subject was calculated by listening to the recorded speech samples with a headset. Whole word articulatory accuracy (W) was judged on the basis of segmental phonemes. A word was regarded as having been articulated inaccurately if there was any segmental deviation from General American English (GAE) pronunciation as described by Kenyon and Knott (23). A phonetic transcription of the test passage constituting the standard against which all speaker samples were judged is included in the Appendix. The values for W_o and T_o were 40 and 15 respectively as described in the Guttman study. Duration of the speech samples was measured to provide T using a Haydon Model K15140 electric laboratory stop clock capable of measuring to 1/100 of a second. An interjudge reliability check on duration timing produced a coefficient of correlation of .99.

(3) Calculation of other speech variables. Total number of phonetic errors on the reading passage; total number of phonetic distortions, phonetic substitutions and phonetic omissions; and total number of misarticulated phonemes was determined using procedures described above.

Interjudge reliability. Studies cited previously by Morrison (36), Sherman and Morrison (43), and Sherman and Cullinan (42) indicated that high interjudge reliability can usually be expected in calculation of speech articulation variables. Interjudge reliability on the speech variables was investigated for this research. Independent scoring on each variable was carried out on twenty-five speaker samples selected at random from the test tapes by one additional listener trained in speech pathology. In all cases the coefficient of correlation was found to be .95 or above.

Preparation of the test tape. All identification numbers used for speaker subjects were collated and randomly selected to determine the order of speakers on the test tape. The test tape was prepared by playing the speaker samples in the randomly determined order on the Sony 777-4 and re-recording using new Scotch "Dynarange" tape on a second high quality tape recorder, a Viking Model 88. A fifteen second interval of silence was provided between speaker samples. During the re-recording process adjustments were made for any remaining disparity in the record intensity level of the speakers. In preparation of the test tape the two sentences, "I will say beet," and "I will say boot" were not re-recorded since this material was used only for the spectrographic analysis.

Listening test procedures. Subjects who were used as speakers were called back to serve as listener subjects. The same data that was recorded for speaker subjects was recorded for listeners on a Listener Data Form (see Appendix). Listeners listened and responded to the test tape in groups of fifteen in a quiet environment. The test tape containing the randomly arranged speech samples was played stereophonically on the Sony 777-4. The dual channel signal was fed from the Sony to the input jacks of a high quality Fisher TX-100 integrated stereophonic master control amplifier. Koss Model T-4 stereophonic connecting boxes were connected to the phone output jack of the Fisher to provide a sufficient number of output jacks for fifteen Sony DR-3C stereophonic headsets. The Sony headsets have a frequency response curve which is flat through 12 000 Hz.

The intensity level of the signal at the headsets was adjusted to produce the most comfortable listening level (MCL) as described by Ward (53). The level was established by playing the test tape for listeners with normal hearing who were not being used as subjects. The MCL was taken as the mean of their individual adjustments of the output gain of the Fisher with the playback level controls on the tape recorder held constant.

Instructions to listeners and data collection. Listeners were told that they were taking part in a study designed to show to what extent certain physical and psychological data can be determined from hearing samples of voice. Two experimentally irrelevant items were included in the listening task in an attempt to partially mask the major intent of the study. This procedure was similar to that used by Dickens and Sawyer (7). Data was collected on the Listener Response Form (see Appendix C). Speaker numbers were printed on the form in the order in which the speaker appeared on the test tape. The listener's own identification number was not written on his response form until after completion of the listening task. It was believed that the effect of any ability on the part of listeners to recognize their own voices on the tape would cancel itself out across the sample. Listener responses on the two variables of racial identification of the speaker and quality rating of the speaker were tabulated.

Treatment of the data. The function of listener and speaker variables in racial identification and quality rating of speakers by listeners was determined using analysis of variance and co-variance and these results are reported in Chapter IV. The analysis was made on the Burroughs B5500 computer with applied multiple linear regression technique as developed by Bottenberg and Ward (3). In describing this technique (vii) the authors state:

> We consider this the most direct and powerful approach to the effective formulation and resolution of a wide variety of research problems. Certain widely used procedures, e.g., analysis of variance and analysis of covariance, are special cases of this general approach.

> It is important to recognize that multiple regression analysis and multivariate correlational analysis are based upon different assumptions although many of the computational aspects of the two procedures are similar. In general, the assumptions underlying the regression approach are less restrictive. Predictor variables in linear regression models, for example, are not assumed to come from multivariate normal distributions.

Spectrographic analysis procedures. As described previously, a sample of the original recorded speech samples was chosen for intergroup spectrographic comparison. The sample used in spectrographic analysis was composed of ten male Negro speakers who had been identified by listeners at least 95% of the time as being Negro speakers. This group of ten was compared with ten male white speakers who had been identified by listeners at least 95% of the time as being white speakers. The sample of the original group of speakers consisted of all male speakers because of the considerable variation found in the acoustic spectra of men and women due to differences in fundamental frequencies of their voices and differences in the size of their vocal tract.

(1) Description of speakers used in spectrographic analysis. Table 6 indicates the socioeconomic status scores of speakers used

in the spectrographic analysis. The difference in the mean scores between the Negro and white groups reflects the difference which exists in the sample as a whole and in the general population of Southern United States. Table 7 describes the mean articulatory product scores of the Negro and white groups compared in spectrographic analysis. As discussed earlier, it is believed that the AP score can be taken as an indicator of overall speech merit.

TABLE 6

MEANS AND RANGES OF SOCIOECONOMIC STATUS SCORES OF SPEAKERS USED IN SPECTROGRAPHIC ANALYSIS

Race of Subjects	Mean SES Score	Range
Negro	30.80	14 - 46
White	63.60	24 - 99
All Subjects	47.20	14 - 99

TABLE 7

MEANS AND RANGES OF ARTICULATORY PRODUCT SCORES OF SPEAKERS USED IN SPECTROGRAPHIC ANALYSIS

Race of Subject	Mean AP Score	Range
Negro	56.90	35 - 80
White	80.30	31 - 99
All Subjects	68.60	31 - 99

The difference in the group means on AP scores reported in Table 7 is quite similar to the difference reported in Chapter IV for the whole sample used in the study. The coefficient of correlation reported in Chapter IV between identification of a speaker as being a Negro speaker and the AP score of that speaker would predict that speakers consistently identified as being Negro speakers would be found to have lower AP scores than speakers consistently identified as being white speakers.

(2) Speech material used in spectrograms. The spectrographic comparison was carried out on the vowels (u) and (i) using the variables of formant frequencies and relative formant amplitudes listed previously in the Experimental Design. These vowels were chosen because, according to Dixon (8), they are most stable and represent extremes physiologically and acoustically, It was believed that, because of this factor, these two vowels might provide the most potential for locating significant spectral differences. Shuy (44) has implied that one of the phonological correlates of socioeconomic stratification may be the presence, absence or substitution of nasal components. According to Dixon (8), the (i) vowel with its high

F_2 and the (u) vowel with its low F_2 are most useful clinically in the diagnosis of nasality. This gave added support to the choice of these vowels for this study. The recorded samples of the vowels to be studied were contained in the short sentences "I will say beet" and "I will say boot" recorded after the test reading passage by all subjects.

(3) Equipment and recording procedure. The spectrographic analysis was carried out on a Kay Electric Company Sona-Graph Model 6061-A. This instrument is an audio frequency spectrum analyzer which produces permanent graphic recordings of any type of complex wave in the range of 85 Hz to 8000 Hz (22). The Sona-Graph is a commercial version of the unit originally developed by Bell Telephone Laboratories and described by Koenig, Dunn and Lacy (25). The test material containing the vowels to be studied was transferred from one channel of the original tape recorded on the Sony 777-4 to the recording turntable of the Sona-Graph. The Sona-Graph 600 ohm input was used as it is compatible with the line output impedence of the Sony 777-4. The gain on the tape recorder was held constant and the input attenuator of the Sona-Graph was adjusted to show a 0 peak on the V U. meter. Since measurements

were carried out on relative rather than absolute formant amplitudes, precise control of input signal intensity was not considered critical.

(4) Reproducing spectrograms. The Sona-Graph is capable of producing two types of graphic display of recorded material: Type 1, a frequency by time display; and Type 2, a frequency by intensity display. All words were reproduced at V.U. meter peaking of -2 using the 45-cycle filter to resolve the harmonics of the vowels being studied. A Type 1 and Type 2 display were made of both test words for every speaker in the sample. The intensity section used for spectral measurement was a frequency by intensity display of a five-millisecond period in the steady state portion of the vowel in each test word. It was believed that it was at this point that there would be minimal influence on the vowel spectrum from surrounding consonants. The steady-state portion was established visually using a procedure described by Dixon (8) and selected from the frequency by time display before removing that display from the display drum. In making the frequency by intensity displays, the 500-cycle tone built into the Sona-Graph was used after each test word to provide a calibration line on the Sona-Graph paper every 500-cycles across the 8000-cycle frequency range.

(5) Formant frequency measurements. The 8000-cycle frequency range of the sound spectrograph was displayed in a vertical distance of four inches on the spectrogram. The calibration tone provided a line on each spectrogram every 500-cycles from 500-cycles through 8000-cycles. The frequency response of the instrument was found to be linear across the frequency range. Discrete frequencies of vowel formants were determined through use of a transparent plastic overlay template. This template was constructed by marking the 500-cycle calibration lines on the plastic and interpolating between the lines. This produced a frequency scale with mark points every 62-cycles and with additional interpolations possible between markings. The first 500-cycle line on the template was aligned with the first 500-cycle line on each amplitude section and formant frequency measurements were made from this reference using the peak of the strongest resonance within the formant band as the formant frequency.

(6) Relative formant amplitude measurements. Following a procedure described by Dixon (8), a transparent plastic intensity scale template was constructed using 1/16 of an inch to represent 1 dB of attenuation. Since the interest was in relative formant

frequency intensities, the O dB line on the template was set in each case on the F_1 peak and readings of relative amplitudes were made from this reference using the variables of $F_1 - F_2$ (difference), $F_2 - F_3$ (difference) and $F_1 - F_3$ (difference) stated in the Experimental Design.

(7) Statistical treatment of the data. Intergroup comparison was carried out on the means described using the data derived by above procedures and results are reported in Chapter IV and t-tests were used to determine statistically significant mean differences. The null hypothesis stated for this part of the study was that no significant differences would be found in intergroup comparison of mean spectrographic values. Alpha was set at .05.

III. PERFORMANCE OF SUBJECT GROUPS ON SPEAKING AND LISTENING TASKS

The articulatory product scores and scores obtained by subjects on the following speech variables were tallied:

1. Number of phonetic errors;
2. Number of phonetic distortions;
3. Number of phonetic substitutions;
4. Number of phonetic omissions;
5. Number of misarticulated phonemes.

The means and ranges for Negro and white, male and female subjects were calculated. This procedure was also carried out on the responses made by subjects on the listening tasks. The group means on all scores were examined for comparison with previous studies and to determine group differences which would necessitate co-variance control in the regression analysis. The group mean scores and ranges are reported in this section.

Articulatory product scores of subjects. Table 8 describes the means and ranges of articulatory product scores of Negro and white subjects with an indication of the relative scores obtained by male and female subjects within each group. The AP score described previously is a semi-objective index of merit of articulatory performance which combines measures of whole word articulatory accuracy and rate of articulation. The measures and calculation can be carried out reliably by one judge. The resulting product has been found to correlate highly with subjective ratings of speech merit offered by groups of judges (15). The scale of AP scores is 0-100 with the latter representing the best possible performance.

TABLE 8

ARTICULATORY PRODUCT SCORES OF SUBJECTS

Race of Subjects	Mean AP Score	Range
Negro	57.34	32 - 83
male	56.26	35 - 80
female	58.66	32 - 83
White	76.79	49 - 95
male	76.22	49 - 95
female	78.15	50 - 95
All Subjects	66.74	32 - 95

It can be noted in Table 8 that the mean score for all subjects was 66.74 and that the ranges and means for Negroes were consistently below that of whites. Within both groups the female speakers were found to score somewhat higher on the scale than the males with a difference of 2.40 for Negroes and 1.93 for whites.

Speech proficiency ratings received by speakers. Perceptions of the overall quality of the tape recorded speech samples were marked by listeners on a three-point scale: 1 good speaker, 2 average speaker, 3 poor speaker (see Appendix C.). The means and ranges of speech proficiency ratings received by speakers are recorded in Table 9 on a scale from 1.00 to 3.00. On this scale the good speaker (best possible rating) is represented by 1.00, the average speaker by 2.00 and the poor speaker (worst possible rating) by 3.00.

Table 9 shows that, in ratings received from all subjects, Negro speakers received consistently lower ratings. The same relative difference exists when ratings offered by Negro listeners and by white listeners are considered separately. In all cases female speakers are consistently judged to be superior speakers.

This finding of relative intergroup differences is the same as that reported in Table 8 concerning the articulatory product scores.

TABLE 9

MEAN SPEECH PROFICIENCY RATINGS RECEIVED BY SPEAKERS

Race of Speakers	Mean Proficiency Rating Received	Range
	Received From All Listeners	
Negro	2.27	1.31 - 2.91
male	2.36	1.38 - 2.88
female	2.16	1.31 - 2.91
White	1.80	1.26 - 2.70
male	1.87	1.26 - 2.67
female	1.80	1.35 - 2.70
All Speakers	2.04	1.26 - 2.91
	Received From Negro Listeners	
Negro	2.22	1.37 - 2.86
male	2.30	1.67 - 2.84
female	2.20	1.37 - 2.86
White	1.79	1.37 - 2.56
male	1.89	1.37 - 2.51
female	1.69	1.44 - 2.56
All Speakers	2.01	1.37 - 2.86

TABLE 9 Continued --

Received From White Listeners		
Negro	2.32	1.21 - 2.95
male	2.42	1.23 - 2.95
female	2.21	1.26 - 2.95
White	1.79	1.12 - 2.84
male	1.87	1.12 - 2.51
female	1.63	1.16 - 2.84
All Speakers	2.06	1.12 - 2.95

NOTE: The scale of speech proficiency in this and in succeeding tables is 1.00 (best possible rating) to 3.00 (lowest possible rating).

Speech proficiency ratings given to speakers by listeners. The previous table described ratings received by speakers and intergroup speaker differences in these ratings were pointed out as they were received from Negro and white listeners. Table 10, on the other hand, indicates ratings given to speakers by listeners. The designations in the far left column of the previous table referred to speakers while the designations of race and sex in Table 10 refer to listeners.

TABLE 10

MEAN SPEECH PROFICIENCY RATINGS GIVEN TO SPEAKERS BY LISTENERS

Race of Listeners	Mean Proficiency Ratings Given	Range
	Ratings Given to All Speakers	
Negro	2.04	1.55 - 2.52
male	2.03	1.55 - 2.43
female	2.04	1.57 - 2.52
White	2.11	1.90 - 2.49
male	2.15	1.91 - 2.49
female	2.01	1.90 - 2.33
All Listeners	2.07	1.57 - 2.52
	Ratings Given to Speakers Perceived to Be Negro	
Negro	2.25	1.65 - 2.71
male	2.22	1.65 - 2.71
female	2.29	1.67 - 2.62
White	2.44	1.89 - 2.88
male	2.47	1.89 - 2.88
female	2.35	2.02 - 2.82
All Listeners	2.34	1.67 - 2.88

TABLE 10 Continued --

Ratings Given to Speakers Perceived to be White

Negro	1.83	1.24 - 2.83
male	1.83	1.40 - 2.24
female	1.74	1.24 - 2.83
White	1.82	1.22 - 2.70
male	1.83	1.41 - 2.13
female	1.78	1.22 - 2.70
All Listeners	1.82	1.22 - 2.83

An important feature to be noted in Table 10 is that there is homogeniety in the way in which Negroes and whites, males and females rate speakers. This congruence of intergroup ratings is the same when speakers are perceived to be Negro and when speakers are perceived to be white. The difference between the mean of 2.34 given to speakers perceived to be Negro and the mean of 1.82 given to speakers perceived to be white is consistent with the intergroup speech proficiency differences noted in the AP score, Table 8, and ratings received by speakers, Table 9.

Subject self-rating of speech proficiency. Table 11 offers means of the self-rating made by Negro and white, male and female subjects. While Negroes can be seen to give themselves poorer ratings than those made by white subjects, this difference is consistent with intergroup speech proficiency differences indicated by the findings reported previously in this chapter. Some tendency can be seen in this table for male subjects of both races to rate themselves somewhat better than those self-ratings made by female subjects. This tendency appears to be slightly stronger among white males.

TABLE 11

SUBJECT SELF-RATING OF SPEECH PROFICIENCY

Race of Subjects	Mean Self-Rating
Negro	2.21
male	2.15
female	2.29
White	1.93
male	1.74
female	2.13
All Subjects	2.07
male	1.94
female	2.21

Listener accuracy in identification of the race of speakers.

Table 12 indicates the mean percentage of accurate racial identifications made by Negro and white, male and female listeners. There is a slight tendency for white listeners to be somewhat more accurate than Negro listeners in racial identification ability with the exception of Negro male and white male identification of white male and female speakers. Generally, males and females tend to be equally accurate in racial identification of speakers. White females had the best mean performance in identifying white speakers and Negro females showed the least accuracy in their identification of whites. These means, 87.24 and 80.12, represent the overall range of accuracy on the identification task. Generally, listeners are seen to be equally accurate in identifying both Negroes and whites.

TABLE 12

LISTENER ACCURACY IN IDENTIFICATION OF THE RACE OF SPEAKERS

Race of Listeners	Mean Percentage of Accuracy	Range
Accuracy in Identification of All Speakers		
Negro	82.38	59.30 - 95.60
male	82.15	59.30 - 95.60
female	83.43	62.90 -93.40
White	85.36	60.40 - 96.70
male	85.06	60.40 - 96.70
female	84.50	76.90 - 93.40
All Listeners	83.82	59.30 - 96.70
Accuracy in Identification of Negro Speakers		
Negro	82.34	27.60 - 100
male	79.65	27.60 - 100
female	81.77	70.20 - 100
White	86.03	65.90 - 100
male	86.55	65.90 - 100
female	84.90	65.90 - 95.70
All Listeners	84.12	27.60 - 100

TABLE 12 Continued --

Accuracy in Identification of White Speakers

Negro	82.30	22.70 - 95.40
male	84.62	65.90 - 95.40
female	80.12	22.70 - 95.40
White	84.56	54.40 - 95.40
male	83.36	54.40 - 95.40
female	87.24	72.70 - 95.40
All Listeners	83.39	22.70 - 95.40

Speaking duration on the test passage. Although duration on the test passage was one of the components used in calculation of the articulatory product score, means were calculated on this factor as an independent variable in Table 13. A consistent difference in performance can be seen between Negro and white speakers and between males and females. The overall range for duration is represented by 14.40 seconds for white males and 18.24 seconds for Negro females.

TABLE 13

SPEAKING DURATION ON THE TEST PASSAGE

Race of Speakers	Mean Duration in Seconds	Range
Negro	17.32	12.32 - 23.81
male	16.58	12.38 - 23.17
female	18.24	12.32 - 23.81
White	14.70	11.30 - 24.58
male	14.40	11.30 - 24.58
female	15.44	13.82 - 19.67
All Speakers	16.05	11.30 - 24.58

NOTE: Optimal speaking duration on the test passage was 15.00 seconds.

Words misarticulated by speakers on the test passage. The total number of words misarticulated was also a component in the articulatory product score, but independent means are provided for this variable in Table 14. It can be noted that, as in the case of previous variables, there is a consistent difference between the mean number of words misarticulated by Negro speakers and the mean number of words misarticulated by white speakers. Negro speakers misarticulated more words than white speakers and Negro females performed better than Negro males. The reverse was true in the case of white speakers with males misarticulating slightly fewer words than females.

TABLE 14

NUMBER OF WORDS MISARTICULATED BY SPEAKERS ON THE TEST PASSAGE

Race of Speakers	Mean Number of Words Misarticulated	Range
Negro	12.82	5 - 23
male	14.69	6 - 22
female	11.24	[illegible] - 23
White	5.68	0 - 17
male	5.65	0 - 14
female	5.77	2 - 17
All Speakers	9.37	0 - 23

NOTE: The reading passage contained a total of 40 words.

Phonetic errors by speakers on the test passage. Consistent differences between the performance of Negro and white speakers can be seen on the three types of phonetic error reported in Table 15 with white speakers having fewer phonetic errors. The difference between the means for Negro and white speakers on phonetic substitutions was 3.16, the difference on omissions was 4.94 and the difference on distortions was 1.66. The same relationship exists between the performance of male and female speakers as was reported in the previous table.

TABLE 15

NUMBER OF PHONETIC ERRORS BY SPEAKERS ON THE TEST PASSAGE

Race of Speakers	Mean No. Substitutions	Mean No. Omissions	Mean No. Distortions	Total
Negro	6.57	6.80	2.93	16.31
male	7.11	6.89	3.19	17.19
female	5.90	6.72	2.62	15.24
White	3.34	1.86	1.27	6.47
male	3.13	1.77	1.32	6.22
female	3.85	2.08	1.15	7.08
All Speakers	5.01	4.41	2.13	11.56

Phonemes misarticulated by speakers on the test passage. The mean number of misarticulated phonemes reported in Table 16 was obtained by counting how many of the 34 phonemes of standard American English were judged to be incorrect on the test passage. The count did not consider the number of times a given phoneme may have been misarticulated. It can be seen that the same consistency of differences between Negroes and whites, males and females is indicated on this table as was noted in previous tables.

TABLE 16

NUMBER OF PHONEMES MISARTICULATED BY SPEAKERS ON THE TEST PASSAGE

Race of Speakers	Mean Number Misarticulated Phonemes	Range
Negro	9.42	1 - 17
male	9.92	1 - 17
female	8.80	2 - 17
White	5.00	0 - 15
male	4.87	0 - 14
female	5.30	2 - 15
All Speakers	7.28	0 - 17

NOTE: The test passage contained 34 phonemes of standard American English.

Summary of subject performance.

1. Negro subjects were found to have consistently lower articulatory product scores than white subjects;
2. Negro speakers were consistently rated lower in speech quality by both Negro and white listeners;
3. The relative difference in quality ratings received by Negro and white speakers was the same when ratings offered by Negro listeners and by white listeners were considered separately;
4. On both the articulatory product score and listener ratings, female speakers of both races were found to have ratings superior to male speakers of both races;
5. There was homogeniety in the way in which Negroes and whites, males and females rated speakers;
6. The homogeniety of intergroup ratings was the same when speakers were perceived to be Negro and when speakers were perceived to be white;
7. Negro speakers rated themselves lower in speech quality than white speakers rated themselves but the difference was consistent with intergroup quality score differences;
8. Male subjects rated themselves better than female subjects rated themselves;

9. Listeners were found to have a range of 80.12% to 87.24% accuracy in the identification of the race of speakers;
10. Listeners were found to be equally accurate in identifying both Negro and white speakers;
11. Negro speakers were found to be slower speakers than white speakers and male subjects were consistently slower than female subjects;
12. Negro speakers were found to misarticulate more words on the test passage than white speakers;
13. Negro subjects were found to have more phonetic errors than white subjects;
14. Negro subjects were found to misarticulate more of the 34 phonemes included in the test passage than white subjects.

Discussion of subject performance. The study by Dickens and Sawyer (7) discussed in Chapter II provides some points of interesting comparison with the subject scores reported here. For instance, their investigation found that listeners were approximately 70% accurate in identifying the race of speaker. This is in contrast to the 83.82% mean listener accuracy found in this study.

Dickens and Sawyer reported having found that white observers were more accurate in racial identification than Negro observers and that there was greater accuracy shown by observers in identifying speakers of their own race. While Table 12 of this study reports a slight difference in identification accuracy in favor of white listeners, the difference is of very low magnitude. In contrast with the finding of Dickens and Sawyer, this study did not show greater accuracy on the part of listeners in identifying speakers of their own race. Dickens and Sawyer found greater accuracy in identifying male speakers. This finding was not confirmed by the present study.

On the matter of speaker quality, Dickens and Sawyer reported that the combined judgement of all speakers rated Negro females and white males as highest in vocal quality. This contrasts with the study reported here in which Table 9 indicates that white males and white females were judged to be the best speakers. The findings of the present study regarding amount of bias apparent in quality rating of speakers agrees with the finding in the study by Dickens and Sawyer in which no bias was found.

One explanation for the contrast in findings between the study reported here and that of Dickens and Sawyer is that the latter study used all university students as subjects. Apparently, there was no attempt to draw a sample which would be somewhat similar to a population on the socioeconomic status variable.

Some findings of the study reported here tend to agree with those presented by Larson and Larson (31). In findings similar to those reported in this study, Larson and Larson found that listeners tend to favor white pronunciations and are able to distinguish between white and Negro speakers with a high degree of accuracy. In the Larson and Larson study, however, there was apparently no attempt to obtain a more objective indicator of speaker quality against which to compare the listener ratings. An important feature of the study reported here is that, while it was found that listeners rate white speech as better than Negro speech, this difference in rating is consistent with differences indicated by the semi-objective AP scores.

The current study confirms the finding reported by Larson and Larson that Negro listeners tend to agree with white listeners in judging the vocal quality of both Negro and white speakers. This may mean, as Larson and Larson imply, that Negroes implicitly accept the white standard of speech performance as more valuable. In the present study there was no consistent intergroup differences in the way in which Negro and white listeners rated Negro and white speakers.

Edmonds (9) found that socioeconomic status had a greater relationship to verbal ability than the sex of the speaker. This finding was confirmed by the present study. The coefficient of correlation between the socioeconomic status score and the AP score was .48 while the relationship of AP to sex was .08.

Two findings of the current study on subject performance contrast with those reported by Stroud (47). It was found by Stroud that listeners were able to correctly identify the race of speakers 93% of the time. This contrasts with the 84% accuracy attained by speakers in this study. Stroud also reported that there was a positive correlation between socioeconomic status and accuracy in identifying the race of speakers. The correlation between these factors in this study was non-significant at .19.

The findings of this study on subject performance indicate that, while the phonological patterns of Negro speakers are identified by listeners with considerable accuracy, there is little difference between the two groups in the standards of speech performance applied to speakers. An implication of this latter finding is that white and Negro listeners can be expected to agree on the quality of performance of speakers. This may mean that if habilitation programs can be structured which are directed at raising the articulatory product scores of Negro speakers, their quality ratings by both Negro and white listeners will be improved.

CHAPTER IV

RESULTS

The purpose of the experimental design and procedures described in the previous chapter was to answer the questions posed for this study in Chapter II. These questions all relate to two area of inquiry: 1. informational content and social dialect analysis directed at specification of variables which may function significantly in the racial identification and quality rating of speakers and, 2. a spectrographic analysis directed at specification of differences which may exist in the vocal resonance characteristics of speakers most consistently identified as Negroes and speakers most consistently identified as whites.

The independent variables selected for information content and social dialect analysis are listed here for review:

1. Race;
2. Age;
3. Sex;
4. Socioeconomic status score;
5. Articulatory product score;
    a. speaking time duration,
    b. number of misarticulated words,

6. Articulation errors;
    a. number of phonetic distortions,
    b. number of phonetic omissions,
    c. number of phonetic substitutions,
7. Total number of misarticulated phonemes;
8. Self-rating of speech proficiency.

The spectrographic analysis was independent of informational content and social dialect analysis and was carried out on a sample of the sample used in that investigation. Variables chosen for intergroup comparison of resonance characteristics included the following:

1. Formant one frequency of the (i) and (u) vowels;
2. Formant two frequency of the (i) and (u) vowels;
3. Formant three frequency of the (i) and (u) vowels;
4. Formant one/formant two relative amplitudes of the (i) and (u) vowels;
5. Formant two/formant three relative amplitudes of the (i) and (u) vowels;
6. Formant one/formant three relative amplitudes of the (i) and (u) vowels.

Ninety-one subjects were chosen to provide the speech data and eighty-six of these individuals served as subjects in the listening task. Subjects were chosen to provide a sample reasonable representative of the distribution of socioeconomic status scores in Southern United States. The experimental procedures described in Chapter III were carried out on this sample.

This chapter will describe the results of the analyses in two sections: 1. results of the regression analysis used to answer the questions posed in Chapter II relative to the function of the independent in the dependent variables and, 2. results of the spectrographic analysis and statistical comparison of means used to answer the question posed in Chapter II concerning possible intergroup differences on spectrographic variables.

I. RESULTS OF REGRESSION ANALYSIS

The function of variables in predicting racial identification and rating of speakers. A regression analysis was carried out on the variables discussed previously. The purpose of the analysis was to answer the questions posed for this study regarding the function of each of the independent variables in determining how speakers are identified as to race and how they are rated in quality by listeners. The independent variables were used to generate full models for regression analysis using the following criterion variables:

1. The number of times speakers were identified as Negro speakers;
2. The number of times speakers were identified as white speakers;
3. The quality rating received by all speakers;
4. The quality rating received by Negro speakers; and
5. The quality rating received by white speakers.

The zero order correlations between the independent and dependent variables were examined for potential significance. From this examination variables were chosen for the full models and the systematically restricted models used in the regression analysis. Table 17 indicates the zero order correlations which were found to exist between the independent variables and the number of times speakers were identified as being Negro speakers and the number of times speakers were identified as being white speakers. Table 18 indicates the zero order correlations which were found to exist between the independent variables and quality ratings received by all speakers from Negro and white listeners. Table 19 indicates the zero order correlations which were found to exist between the independent variables and quality ratings received by Negro and white speakers.

TABLE 17

ZERO ORDER CORRELATIONS BETWEEN INDEPENDENT VARIABLES AND THE RACIAL IDENTIFICATION OF SPEAKERS

Variable	Correlation	
	With Percentage Speaker Perceived as Negro	With Percentage Speaker Perceived as White
(X_1) Race - Negro	0.8469	-0.8603
(X_2) Race - White	-0.8469	0.8603
(X_3) Age	0.2081	-0.2016
(X_4) Sex - Male	-0.1242	0.0985
(X_5) Sex - Female	0.1242	-0.0985
(X_6) SES Score	-0.4841	0.4796
(X_7) AP Score	-0.6566	0.6723
(X_8) Rating by Listeners	0.6239	-0.6322
(X_9) by Negroes	0.6257	-0.6243
(X_{10}) by Whites	0.6648	-0.6645
(X_{11}) Ratings given toSpeakers	-0.2675	0.2318
(X_{12}) to Negroes	-0.4051	0.3824
(X_{13}) to Whites	-0.0570	0.0325
(X_{14}) Self-rating	0.3048	-0.2750
(X_{15}) Duration	0.2503	-0.2663
(X_{16}) Number of Misarticulated words	0.7158	-0.7306

TABLE 17 Continued --

(X_{17})	Number of Phonetic Errors	0.6729	-0.6818
(X_{18})	Number of Substitutions	0.6386	-0.6311
(X_{19})	Number of Omissions	0.5666	-0.5760
(X_{20})	Number of Distortions	0.5214	-0.5545
(X_{21})	Number of Misarticulated Phonemes	0.6418	-0.6516

TABLE 18

ZERO ORDER CORRELATIONS BETWEEN INDEPENDENT VARIABLES AND THE QUALITY RATING RECEIVED BY ALL SPEAKERS

Variable	Correlation with Rating Received		
	By All Speakers	From Negro Listeners	From White Listeners
(X_1) Race - Negro	0.4888	0.4909	0.5114
(X_2) Race - White	-0.4888	-0.4909	-0.5114
(X_3) Age	-0.1084	-0.1144	-0.0952
(X_4) Sex - Male	0.1267	0.1084	0.1174
(X_5) Sex - Female	-0.1267	-0.1084	-0.1174
(X_6) SES Score	-0.6315	-0.6242	-0.6497
(X_7) AP Score	-0.7303	-0.7434	-0.7220
(X_8) Ratings by Listeners	-0.2394	-0.3102	-0.2341
(X_9) by Negroes	-0.2613	-0.3150	-0.2894
(X_{10}) by Whites	-0.0959	-0.1387	-0.0677
(X_{14}) Self-rating	0.2965	0.2962	0.3123
(X_{15}) Duration	0.2176	0.2414	0.1896
(X_{16}) Total Misarticulated Words	0.7553	0.7726	0.7621

TABLE 18 Continued --

(X_{17})	Total Phonetic Errors	0.7214	0.7414	0.7236
(X_{18})	Total Substitutions	0.7170	0.7356	0.7245
(X_{19})	Total Omissions	0.6146	0.6419	0.6247
(X_{20})	Total Distortions	0.4501	0.4323	0.4144
(X_{21})	Total Misarticulated Phonemes	0.6992	0.7113	0.7062

TABLE 19

ZERO ORDER CORRELATIONS BETWEEN INDEPENDENT VARIABLES AND THE QUALITY RATING RECEIVED BY NEGRO AND WHITE SPEAKERS

Variable	Correlations with Rating Received	Correlations with Rating Received
	By Negro Speakers	By White Speakers
(X_1) Race - Negro	0.0000	0.0000
(X_2) Race - White	0.0000	0.0000
(X_3) Age	-0.4378	-0.3496
(X_4) Sex - Male	0.2166	0.2653
(X_5) Sex - Female	-0.2166	-0.2653
(X_6) SES Score	-0.6808	-0.4148
(X_7) AP Score	-0.5670	-0.7187
(X_{14}) Self-rating	-0.3056	0.3048
(X_{15}) Duration	0.0035	0.0368
(X_{16}) Total Misarticulated Words	0.6485	0.7021
(X_{17}) Total Phonetic Errors	0.6322	0.6384
(X_{18}) Total Substitutions	0.6309	0.6420
(X_{19}) Total Omissions	0.5721	0.3947
(X_{20}) Total Distortions	0.0945	0.6644
(X_{21}) Total Misarticulated Phonemes	0.5921	0.6349

The following independent variables were used in the initial full predictor model generated for regression analysis:

1. Race of speaker (Negro or white);
2. Age of speaker;
3. Sex of speaker;
4. Socioeconomic status score;
5. Articulatory product score;
6. Ratings received by speakers;
7. Self-ratings made by speakers;
8. Racial identification accuracy;
9. Speaking duration;
10. Total misarticulated words;
11. Total phonetic errors;
12. Total phonetic substitutions;
13. Total phonetic omissions;
14. Total phonetic distortions;
15. Total misarticulated phonemes.

The full model was sytematically restricted by removal of variables and analyzed with the criterion variables to test hypotheses regarding the function of the independent in the dependent variables. The F-ratios resulting from the different combinations of full and restricted models were checked by comparison with the theoretical F distribution. The regression analysis was carried out on the Burroughs B5500 electronic data processing system using a program based upon the work of Bottenberg and Ward (3) which was described in Chapter III.

Table 20 lists the five criterion variables developed from the questions posed for this study in Chapter II. The predictor variables are those found to produce significant F-ratios when the full models were restricted by these variables and run against the criterion variables in regression analysis. The five criterion variables listed previously were found to produce three predictor variables whose F-ratios indicate that they are significant factors in the racial identification and rating of Negro and white speakers by Negro and white listeners. Analysis of co-variance was used to control for intergroup mean difference on the socioecomomic status scores and the articulatory product scores. The significance of the predictor variables in predicting the dependent variables listed previously was

TABLE 20

SIGNIFICANT PREDICTOR VARIABLES

Criterion variable	Predictor variable	r	Probability	F-ratio	Level of Significance
(y_1) Times speaker perceived as Negro speaker	Number of Phonetic Distortions	.52	.01	5.86	.05
(y_2) Times speaker perceived as white speaker	Number of Phonetic Distortions	-.55	.003	9.10	.01
(y_3) Quality ratings received by speakers	Socioeconomic Status Score	-.63	.007	7.62	.01
	Articulatory Product Score	-.73	.001	10.46	.01
(y_4) Quality ratings received by Negro speakers	Socioeconomic Status Score	-.68	.007	7.62	.01
	Articulatory Product Score	-.56	.001	10.46	.01

TABLE 20 CONTINUED

Criterion variable	Predictor variable	r	Probability	F-ratio	Level of Significance
(y_5) Quality ratings received by white speakers	Socioeconomic Status Score	-.41	.007	7.62	.01
	Articulatory Product Score	-.72	.001	10.46	.01

maintained under this control.

Table 20 indicates that the number of phonetic distortions made by the speaker is important in determining whether he will be perceived as a Negro speaker or whether he will be perceived as a white speaker. The correlation of .52 between criterion variable y, and phonetic distortion indicates that the greater the number of distortions the more likely it is that a given speaker will be identified as a Negro speaker. The -.55 correlation between criterion variable y_2 and phonetic distortions indicates that the fewer the number of distortions the more likely it is that a given speaker will be identified as a white speaker.

The quality ratings received by both Negro and white speakers (y_3, y_4, y_5) were significantly predicted by the socioeconomic status scores at the .01 level and by the articulatory product scores at the .01 level of confidence. The negative correlations would make it appear that, as SES score and AP score go down, quality rating goes up. The reverse of this is the case, however, since the scale of quality rating in the study used number 1 for best speakers and number 3 for poorest speakers. High ratings on the scale means speakers were judged to be average or poor speakers. The -.73 correlation between the AP score and quality ratings received by all speakers indicates, for instance, that as these scores go down, speakers become rated as poorer speakers. The same relationship exists in the case of the SES scores as indicated by the -.63 correlation with ratings received.

Number of phonetic distortions, SES score, and AP score were the only independent variables found to be significant in the regression analysis. The remaining variables included in the questions in Chapter II and listed previously in this chapter were not found to function significantly in the racial identification and rating of Negro and white speakers by Negro and white listeners. F-ratios for all variables are reported in Appendix D.

II. RESULTS OF SPECTROGRAPHIC ANALYSIS

A major question posed for this study was whether significant mean differences could be found to exist on selected acoustic variables between a group of speakers consistently judged by listeners to be Negro and a group of speakers consistently judged by listeners to be white. Table 21 indicates means and ranges of the formant frequencies of the (i) vowel. Although the mean F_2 frequency and the mean F_3 frequency for Negroes is below that of whites, this relationship does not exist for the F_1 frequency. No consistent or significant intergroup differences could be found on this variable, using a t-test (see Appendix E).

TABLE 21

MEANS AND RANGES OF THE FORMANT FREQUENCIES OF THE (i) VOWEL

Race of Speakers	Mean Formant Frequency	Range
Negro	F_1 - 260 Hz	187 Hz - 343 Hz
	F_2 - 2222 Hz	1968 Hz - 2437 Hz
	F_3 - 2831 Hz	2500 Hz - 3250 Hz

TABLE 21 Continued --

White	F_1 - 319 Hz	218 Hz - 437 Hz
	F_2 - 2076 Hz	1795 Hz - 2500 Hz
	F_3 - 2738 Hz	2250 Hz - 3312 Hz
All Speakers	F_1 - 289 Hz	187 Hz - 437 Hz
	F_2 - 2149 Hz	1795 Hz - 2500 Hz
	F_3 - 2784 Hz	2250 Hz - 3312 Hz

Table 22 reports the means and ranges of relative formant amplitudes for the (i) vowel. In comparing the means on the relative amplitudes of Negro subjects with those of white subjects, greater formant amplitude differences can be noted for the Negroes. Although greater formant amplitude differences can be noted for the group of Negro subjects, the differences between the means of the two groups were not found to be significant using a t-test (see Appendix E).

TABLE 22

MEANS AND RANGES OF RELATIVE FORMANT AMPLITUDES FOR THE (i) VOWEL

Race of Speakers	Mean Relative Amplitude in Decibels	Range
Negro	F_1/F_2 - 3.80	1 - 7
	F_2/F_3 - 2.20	0 - 4
	F_1/F_3 - 3.00	0 - 6
White	F_1/F_2 - 3.00	1 - 5
	F_2/F_3 - 2.00	0 - 4
	F_1/F_3 - 2.00	0 - 6
All Speakers	F_1/F_2 - 3.40	1 - 7
	F_2/F_3 - 2.10	0 - 4
	F_1/F_3 - 2.50	0 - 6

Table 23 reports the means and ranges of the formant frequencies of the (u) vowel. No consistent relationship could be found in the data for the two groups and the differences between the means were not found to be significant using a t-test (see Appendix E).

TABLE 23

MEANS AND RANGES OF THE FORMANT FREQUENCIES OF THE (u) VOWEL

Race of Speakers	Mean Formant Frequency	Range
Negro	F_1 - 284 Hz	156 Hz - 417 Hz
	F_2 - 1033 Hz	709 Hz - 1187 Hz
	F_3 - 2326 Hz	1935 Hz - 2562 Hz
White	F_1 - 400 Hz	218 Hz - 468 Hz
	F_2 - 1353 Hz	1125 Hz - 1937 Hz
	F_3 - 2212 Hz	1968 Hz - 2562 Hz

TABLE 23 Continued --

All Speakers	F_1 - 342 Hz	156 Hz - 468 Hz
	F_2 - 1983 Hz	709 Hz - 1937 Hz
	F_3 - 2269 Hz	1935 Hz - 2562 Hz

Table 24 reports the means and ranges of relative formant amplitudes for the (u) vowel. Although the same consistently lower relative formant amplitudes were found for Negro speakers on the (u) vowel as were reported for the (i) vowel, the differences between the means for the two groups were not found to be significant using a t-test (see Appendix E).

TABLE 24

MEANS AND RANGES OF RELATIVE FORMANT AMPLITUDES FOR THE (u) VOWEL

Race of Speakers	Mean Relative Amplitude in Decibels	Range
Negro	F_1/F_2 - 5.40	3 - 7
	F_2/F_3 - 4.50	1 - 7
	F_1/F_3 - 9.90	6 - 12

TABLE 24 Continued --

White	F_1/F_2 - 4.30	1 - 8
	F_2/F_3 - 2.90	2 - 6
	F_1/F_3 - 5.60	0 - 11
All Speakers	F_1/F_2 - 4.85	1 - 8
	F_2/F_3 - 3.70	1 - 7
	F_1/F_3 - 7.75	0 - 12

III. SUMMARY OF RESULTS

1. Number of phonetic distortions was found to be significant in predicting when a recorded speech sample would be identified as having been performed by a Negro speaker;
2. Number of phonetic distortions was found to be significant in predicting when a recorded speech sample would be identified as having been performed by a white speaker;
3. The socioeconomic status score of the speaker and the articulatory product score of the speaker were found to be significant in predicting the speech quality rating received by the speaker from listeners;
4. The following independent variables included in the questions posed for this research in Chapter II were not found, through the regression analysis, to function significantly in listener perception of racial identity and quality rating of speakers (see F-ratios listed in Appendix D):
    1. Age;
    2. Sex;
    3. Articulation errors;
        a. number of phonetic omissions,
        b. number of phonetic substitutions,
    5. Total number of misarticulated phonemes;
    6. Self-rating of speech proficiency.

5. No significant differences were found between the Negro and white means on formant frequencies of the (i) and (u) vowels;
6. The relative formant amplitudes of Negro speakers on (i) and (u) were consistently lower than those of white speakers but this difference was not found to be significant.

CHAPTER V

DISCUSSION AND SUMMARY

The discussion will be divided into three sections: 1. the findings of this study relative to informational content and social dialect analysis; 2. the results of the spectrographic analysis and; 3. suggestions for further research. These sections will be followed by a summary of the study.

I. INFORMATIONAL CONTENT AND SOCIAL DIALECT ANALYSIS

It is believed that the most important results reported in the previous chapter are those contributed by the regression analysis. Apparently, the number of phonetic distortions is significant in predicting whether recorded speech samples will be identified as having been performed by a Negro or by a white speaker. This finding contributes basic information in the psychoacoustics of speech which may prove to be useful to school personnel and others interested in intergroup communication and socio-linguistic cues carried in speech signals. The strength of the prediction applies to all speakers, Negro and white. Apparently, number of phonetic distortions functioned significantly in cases in which white speakers were identified as being Negro speakers and in cases in which Negro speakers were thought to be white speakers.

Subsequent checking of the speaker data indicated that in all cases phonetic distortions applied to vowel sounds. This would mean that significant cues for racial perception in the recorded samples were related to vowel production.

The finding that the articulatory product score is significant in predicting how white and Negro speakers will be rated by white and Negro listeners offers further validation of this instrument. The articulatory product score reflects speaker performance on the factors of duration and whole word articulatory accuracy. The zero order correlations between these two factors and speaker rating were .21 for duration and .75 for total misarticulated words. The higher correlation between the AP score and total misarticulated words indicates that this factor contributed the greatest strength to the prediction relationship. This may provide information helpful in structuring dialect remediation programs.

The socioeconomic status score combined occupation, income and education. Since the analysis did not distinguish these factors, it is not possible to estimate the relative strength each may have contributed to the prediction relationship.

II. SPECTROGRAPHIC ANALYSIS

Ladefoged (29) says that the idiosyncratic features of speech signals which provide personal information about speakers may be attributed to anatomical and physical characteristics of the individual speaker such as the shape, size and coupling of resonance cavities of the vocal tract. Group features providing socio-linguistic information are, according to Ladefoged, most attributable to the influence of the particular groups in which the speaker is or has been a member. It can be inferred from this distinction that Ladefoged does not believe that the communication of socio-linguistic information is a function of vocal tract resonance characteristics which would make distinguishable differences in spectrographic displays. The results of the intergroup spectrographic analysis reported in Chapter IV would tend to confirm this opinion in reference to the particular acoustic features examined in this study. It should be pointed out, on the other hand, that both the number of features studied and sample size were limited in this phase of the research.

III. SUGGESTION FOR FURTHER RESEARCH

One of the recognized limitations of the study reported here is that the speech material used for analysis was acquired through use of a reading passage. Since this was a speech study that did not include non-phonological aspects of spoken language as variables to be investigated, it was believed that the advantages of controlled sampling outweighed the recognized disadvantages of using a reading passage for gathering speech material. In view of the possible qualification of these results due to the restriction imposed by the reading passage, further research should be carried out to determine whether the reported relationship of variables would remain constant under condtions of extemporaneous speech material.

The problems in social dialect and informational content analysis formulated for this particular study were limited to analysis of variables which might be found to predict the racial identification and rating of speakers. The social dialect analysis should be extended through continued research to further specify the relationship of variables found to be significant in this study.

The spectrographic analysis reported here should be continued. Other phonemes and acoustic parameters should be investigated as part of research directed at a clearer understanding of perceptual cues in speech signals. Such features as formant bandwidth, interformant fill, duration, and vowel transition characteristics may prove to be useful areas of inquiry in future attempts to specify acoustic correlates of racial perception. The finding reported in Chapter IV of consistently reduced formant amplitudes among the Negro speakers studied may also indicate the need for further investigation.

IV. SUMMARY

This study used ninety-one subjects in an attempt to specify social and acoustic variables which function significantly in the racial identification and rating of Negro and white speakers by Negro and white listeners. Eighty-six subjects, forty-three white and forty-three Negro, provided the listener responses. Subjects were chosen to provide a sample approximately representative of the distribution of socioeconomic status scores in Southeastern United States.

Listeners were asked to judge the race and overall speech proficiency of speakers from listening to a recorded reading passage. Comparative control was exercised over the quality ratings through the use of a semi-objective articulatory product score which provided an independent index of speech proficiency. Additional independent variables included the socioeconomic status score; sex; age; number of articulation errors divided into substitutions, omissions and distrotions; number of misarticulated phonemes and a self-rating of speech proficiency. All speaker and listener data were gathered under controlled laboratory conditions. Analysis was carried out through analysis of variance and co-variance using multiple regression technique to determine variables which might be significant in predicting racial identity perception and quality rating of speakers.

A spectrographic analysis was carried out using a sample of the sample consisting of ten Negro male and ten white male subjects. All speakers used in this analysis had been correctly identified by listeners as to race 95% of the time or better.

The purpose of this phase of the study was to specify spectral data in the resonance characteristics of speakers as seen in two selected vowel sounds which might function significantly in listener perception of racial identity and the quality rating of speakers. An intergroup comparison was carried out on the acoustic variables of formant frequency and relative formant amplitude from spectrographic displays of the (i) and (u) vowels.

The results can be summarized as follows:

1. Number of phonetic distortions is significant in predicting listener identification of the race of speakers from recorded speech samples.
2. Socioeconomic status score and articulatory product score are significant factors in predicting speech quality ratings received by Negro and white speakers from Negro and white listeners.
3. No significant intergroup differences were found in the comparison carried out on acoustic variables from spectrographic displays. The Negro speakers were found, however, to have consistently lower relative formant frequencies than the white group.

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APPENDIX A.

SPEAKING TEST PASSAGE AND PHONETIC TRANSCRIPTION

MANY PEOPLE WANT TO HAVE RELATIVELY
[mɛnɪ pipl̩ wɔnt tu hæv rɛlətɪvlɪ

HEAVY BREAKFASTS THAT INCLUDE A RICH
hɛvɪ brɛkfəsts ðæt ɪnklud ə rɪtʃ

SWEET SUCH AS CAKE. OTHERS PURPOSELY
swit sʌtʃ əz kek|| ʌðɝz pɝpəslɪ

RESTRICT THEMSELVES TO A GLASS OF
rɪstrɪkt ðəmsɛlvz tu ə glæs əv

ORANGE JUICE. SOME FREQUENTLY GO
ɔrɪndʒ dʒus|| sʌm frɪkwɛntlɪ go

WITHOUT A MORNING MEAL. DO THOSE
wɪðaut ə mɔrnɪŋ mil du ðoz

WHO EAT LIGHTLY LUNCH EARLY?
hu it laɪtlɪ lʌntʃ ɝlɪ||]

I WILL SAY BEET.

I WILL SAY BOOT.

APPENDIX B.

QUESTIONNAIRE

NUMBER ____________

DATE ____________

QUESTIONNAIRE

(NOTE: All information on this form is kept strictly confidential)

NAME ______________________________

ADDRESS ______________________________

____

AGE _____ SEX: MALE ( ), FEMALE ( )

TELEPHONE NUMBER ______________________________

EMPLOYED BY ______________________________

____

TELEPHONE AT WORK ______________________________

DO NOT WRITE IN THIS SPACE

h.ch.	hearing
sp.ch.	speech
e.b.	ethnic
l.b.	linguistic
g.h.	health
sp.tr.	speech train.
r.a.	reading

PLEASE FILL IN ALL OF THE FOLLOWING INFORMATION:

(1) OCCUPATION of the chief income recipient of the family

____

(2) EDUCATION of the chief income recipient of the family (please circle the highest year completed in school)

Elementary	1	2	3	4	5	6	7	8
High School	1	2	3	4				
College	1	2	3	4	5	or more		

(3) INCOME Total income for the whole family per year (please check correct answer)

_____ Loss, none or less that $500

_____ $500 to $999

_____ $1000 to $1499

_____ $1500 to $1999

_____ $2000 to $2499

_____ $2500 to $2999

_____ $3000 to $3499

_____ $3500 to $3999

_____ $4000 to $4499

_____ $4500 to $4999

_____ $5000 to $5499

_____ $5500 to $5999

_____ $6000 to $6499

_____ $6500 to $6999

_____ $7000 to $7499

_____ $7500 to $7999

_____ $8000 to $8499

_____ $8500 to $8999

_____ $9000 to $9499

_____ $9500 to $9999

_____ $10,000 to $14,999

_____ $15,000 to $24,999

_____ $25,000 or more

(4) PLEASE CHECK ONE:

_____ I think I am a good speaker

_____ I think I am an average speaker

_____ I think I am a poor speaker

APPENDIX C.

LISTENER RESPONSE FORM

NUMBER ____________
DATE ____________

LISTENER RESPONSE FORM

NAME ____

INSTRUCTIONS: Please respond to EVERY question about EVERY speaker. Mark ONE answer in every block for each speaker even if you are undecided and must guess. You will have 15 seconds between each speaker to mark your form. Answer each question by putting a CIRCLE around your choice. Be sure to answer all 4 questions about each speaker.

SPEAKER 1

(1) VOCAL QUALITY (circle one) GOOD SPEAKER AVERAGE SPEAKER POOR SPEAKER	(2) SEX (circle one) MALE FEMALE
(3) AGE (circle one) 15-25 25-40 40-60	(4) ETHNIC BACKGROUND (circle one) NEGRO WHITE

SPEAKER 2

(etc.)

APPENDIX D

Key to Variables and Combinations of Variables Used in Full and Restricted Models

Full Models Used in Analysis

Tables of the Effects on Dependent Variables Attributable to the Independent Variables

KEY TO VARIABLES AND COMBINATIONS OF VARIABLES USED IN FULL AND RESTRICTED MODELS

Predictor Variables

Number	Variable or Combination
2	Negro speaker
3	White speaker
4	Age of speaker
5	Male speaker
6	Female speaker
7	Socioeconomic status score (SES)
8	Articulatory product score (AP)
9	Quality rating received by speaker
15	Self-rating made by speaker
16	Accuracy in racial identification
37	Number of phonetic substitutions
39	Number of phonetic distortions
40	Number of misarticulated phonemes
41	Unit vector
42	2 x 7
43	3 x 7
44	2 x 8
45	3 x 8
46	2 x 9
47	3 x 9

48	2 x 16
49	3 x 16
50	2 x 37
51	3 x 37
52	2 x 38
53	3 x 38
54	2 x 39
55	3 x 39
56	2 x 40
57	3 x 40
58	if not zero, element in vector 44 minus mean of 47 persons in group, else zero
59	if not zero, element in vector 45 minus mean of 44 persons in group, else zero
60	if not zero, element in vector 46 minus mean of 47 persons in group, else zero
61	if not zero, element in vector 47 minus mean of 44 persons in group, else zero
62	if not zero, element in vector 48 minus mean of 47 persons in group, else zero
63	if not zero, element in vector 49 minus mean of 44 persons in group, else zero
64	if not zero, element in vector 50 minus mean of 47 persons in group, else zero
65	if not zero, element in vector 51 minus mean of 44 persons in group, else zero
66	if not zero, element in vector 52 minus mean of 47 persons in group, else zero

67	if not zero, element in vector 53 minus mean of 44 persons in group, else zero
68	if not zero, element in vector 54 minus mean of 47 persons in group, else zero
69	if not zero, element in vector 55 minus mean of 44 persons in group, else zero
70	if not zero, element in vector 56 minus mean of 47 persons in group, else zero
71	if not zero, element in vector 57 minus mean of 44 persons in group, else zero
72	58 + 59
73	60 + 61
74	62 + 63
75	64 + 65
76	66 + 67
77	68 + 69
78	70 + 71

Criterion Variables

23	Times speaker perceived as Negro speaker
29	Times speaker perceived as white speaker
9	Quality rating received by speakers

FULL MODELS USED IN ANALYSIS

1. Criterion variable: 23

(A)	(B)	(C)	(D)
2 - 4	2 - 8	2 - 7	2 - 7
15 - 15	15 - 15	9 - 9	15 - 16
41 - 41	41 - 41	15 - 15	41 - 41
72 - 78	73 - 78	41 - 41	72 - 73
		72 - 72	75 - 78
		74 - 78	

(E)	(F)	(G)	(H)
2 - 7	2 - 7	2 - 7	2 - 7
15 - 15	15 - 15	15 - 15	15 - 15
37 - 37	38 - 38	39 - 39	40 - 41
41 - 41	41 - 41	41 - 41	72 - 77
72 - 74	72 - 75	72 - 76	
76 - 78	77 - 78	78 - 78	

2. Criterion variable: 29

(A)	(B)	(C)	(D)
2 - 7	2 - 8	2 - 7	2 - 7
15 - 16	15 - 15	9 - 9	15 - 15
41 - 41	41 - 41	15 - 15	37 - 37
72 - 73	73 - 78	41 - 41	41 - 41
75 - 78		72 - 72	72 - 74
		74 - 78	76 - 78

(E)	(F)	(G)
2 - 7	2 - 7	2 - 7
15 - 15	15 - 15	15 - 15
38 - 38	39 - 39	40 - 41
41 - 41	41 - 41	72 - 77
72 - 75	72 - 76	
77 - 78	78 - 78	

3. Criterion variable: 9

(A)	(B)
2 - 8	2 - 7
15 - 16	15 - 15
37 - 38	39 - 39
40 - 41	41 - 41
77 - 77	72 - 76
	78 - 78

TABLE 25

ANALYSIS OF THE EFFECTS ON TIMES SPEAKER PERCEIVED AS NEGRO ATTRIBUTABLE TO VARIABLES LISTED

Variables	Number of Predictor Variables	RSQ	$\frac{F^1}{(p)^2}$	$(df)_1$	$(df)_2$	Significance * 5% Level ** 1% Level
Full Model (includes 15 variables)	15	.8128				
Restricted Models						
1. Race removed	13	.4514	164.04 (.0..01)	1	85	**[3]
2. Age removed	14	.8198	0.00 (0)	1	85	
3. Sex removed	13	.8169	0.00 (0)	1	85	
4. SES removed	14	.8156	0.00 (0)	1	85	
5. Self-rating removed	14	.8198	0.00 (0)	1	85	
6. AP removed	14	.8171	1.41 (.23)	1	85	
7. Rating received removed	14	.8171	1.51 (.22)	1	85	
8. Racial identification accuracy removed	14	.8199	0.14 (.70)	1	85	

TABLE 25 Continued - -

9. Phonetic substitutions removed	14	.8133	2.19 (.14)	1	85	
10. Phonetic omissions removed	14	.8199	0.00 (.93)	1	85	
11. Phonetic distortions removed	14	.8148	5.86 (.01)	1	85	*
12. Misarticulated phonemes removed	14	.8202	0.00 (0)	1	85	

---

[1] $$F = \frac{(RSQ_{Full} - RSQ_{RSTR}) / (df)_1}{1 - RSQ_{Full}) / (df)_2}$$

[2] Probability

[3] Indicates that actual race is significant in predicting how listeners will identify speakers from listening to recorded speech samples

TABLE 26

ANALYSIS OF THE EFFECTS ON TIMES SPEAKER PERCEIVED AS WHITE ATTRIBUTABLE TO VARIABLES LISTED

Variables	Number of Predictor Variables	RSQ	$\frac{F^1}{(p)^2}$	$(df)_1$	$(df)_2$	Significance * 5% Level ** 1% Level
Full Model (includes 15 variables)	15	.8392				
Restricted Models						
1. Race removed	13	.4244	219.23 (2.95)	1	85	**[3]
2. Age removed	14	.8343	2.55 (.10)	1	85	
3. Sex removed	13	.8355	1.91 (.16)	1	85	
4. SES removed	14	.8368	1.24 (.26)	1	85	
5. Self-rating removed	14	.8392	0.00 (0)	1	85	
6. Racial identification accuracy removed	14	.8392	0.00 (0)	1	85	
7. AP removed	14	.8390	0.00 (0)	1	85	
8. Rating received removed	14	.8368	1.26 (.26)	1	85	

TABLE 26 Continued - -

9. Phonetic substitutions removed	14	.8388	0.00 (0)	1	85	
10. Phonetic omissions removed	14	.8372	0.00 (0)	1	85	
11. Phonetic distortions removed	14	.8287	9.10 (.003)	1	85	**
12. Misarticulated phonemes removed	14	.8392	0.00 (0)	1	85	

---

[1] $$F = \frac{(RSQ_{Full} - RSQ_{RSTR}) / (df)_1}{1 - (RSQ_{Full}) / (df)_2}$$

[2] Probability

[3] Indicates that actual race is significant in predicting how listeners will identity speakers from listening to recorded speech samples

TABLE 27

ANALYSIS OF THE EFFECTS ON QUALITY RATINGS RECEIVED BY SPEAKERS ATTRIBUTABLE TO VARIABLES LISTED

Variables	Number of Predictor Variables	RSQ	$\frac{F^1}{(p)^2}$	$(df)_1$	$(df)_2$	Significance * 5% Level ** 1 % Level
Full Model (includes 14 variables)	14	.6727				
Restricted Models						
1. Race removed	12	.6632	2.48 (.11)	1	85	
2. Age removed	13	.6665	1.61 (.20)	1	85	
3. Sex removed	12	.6717	0.27 (.60	1	85	
4. SES removed	13	.6434	7.62 (.007)	1	85	**
5. AP removed	13	.6325	10.46 (.001)	1	85	**
6. Self-rating removed	13	.6718	0.25 (.61)	1	85	
7. Racial identification accuracy removed	13	.6727	0.00 (0)	1	85	
8. Phonetic substitutions removed	13	.6721	0.15 (.69)	1	85	

TABLE 27 Continued --

9.	Phonetic omissions removed	13	.6727	0.00 (0)	1	85
10.	Misarticulated phonemes removed	13	.6723	0.11 (.74)	1	85
11 .	Phonetic distortions removed	13	.6695	2.80 (.09)	1	85

---

[1] $$F = \frac{(RSQ_{Full} - RSQ_{RSTR}) / (df)_1}{1 - RSQ_{Full}) / (df)_2}$$

[2] Probability

APPENDIX E

t -RATIOS RESULTING FROM COMPARISON OF MEANS OF SPECTROGRAPHIC VARIABLES

TABLE 28

t -RATIOS RESULTING FROM COMPARISON OF MEANS OF SPECTROGRAPHIC VARIABLES

Variable	Difference Between the Means	t-ratio
	(i) Vowel	
F_1	59	2.02
F_2	146	1.11
F_3	93	.60
F_1/F_2	.80	.40
F_2/F_3	.20	.29
F_1/F_3	1.00	.85
	(u) Vowel	
F_1	116	1.25
F_2	320	1.14
F_3	114	.83
F_1/F_2	1.10	1.10
F_2/F_3	1.60	2.08
F_1/F_3	4.30	1.50

NOTE: Critical value of t at 18 degrees of freedom = 2.10 for .05 level.

APPENDIX F

RATIONALE FOR ANALYSIS TAKEN FROM BOTTENBERG AND WARD (3)

Careful consideration of this outline in conjunction with Figures 1, 2, and 3 will disclose the logic governing the sequence in which estimates for restricted models should be obtained for *any* problem of this type. The numbers in parentheses refer to sections of the text which fully describe the analyses.

Sequence of Tests of Hypotheses

Question	Mathematical Expression	Analysis	Answer	Figure
1. Is amount of change in criterion per unit of concomitant variable the *same* for both treatments over observed range of concomitant variable?	$k_3 = k_4$	(5.2.4.1)		
			Yes	1
			No	2 or 3
Given $k_3 = k_4$				
2. Are the two treatments *equally* effective over observed range of the concomitant variable?	$k_1 = k_2$, i.e., $d = k_1 - k_2 = 0$	(5.2.4.2)		
			Yes	1 (superimposed lines)
			No	1
Given $k_3 \neq k_4$				
3. At what point (a_0) on concomitant variable may both treatments be expected to be equally effective? Is a_0 within range of interest?	If a_0 is estimate of m_0 (in Fig. 3), $a_0 = \frac{k_2 - k_1}{k_3 - k_4}$	(5.2.4.3)		
			Yes	3
			No	2

The flowchart in Figure 4 outlines the sequence of steps necessary for comparing the effects of two treatments when a concomitant variable may be operative. The principles that determine this sequence are applicable to problems involving several treatments and several concomitant variables. In such problems, however, there are more relationships possible between the criterion and concomitant variables; and these relationships may differ from treatment to treatment. If the relationships do differ, any conclusion about the superiority of a treatment is contingent upon the range of values of the concomitant variables that are considered simultaneously. However, when the relationships can be shown to be constant from treatment to treatment, the determination of which one of several treatments is superior can be made by following a sequence of steps analogous to that shown in Figure 4 for two-treatment problems.

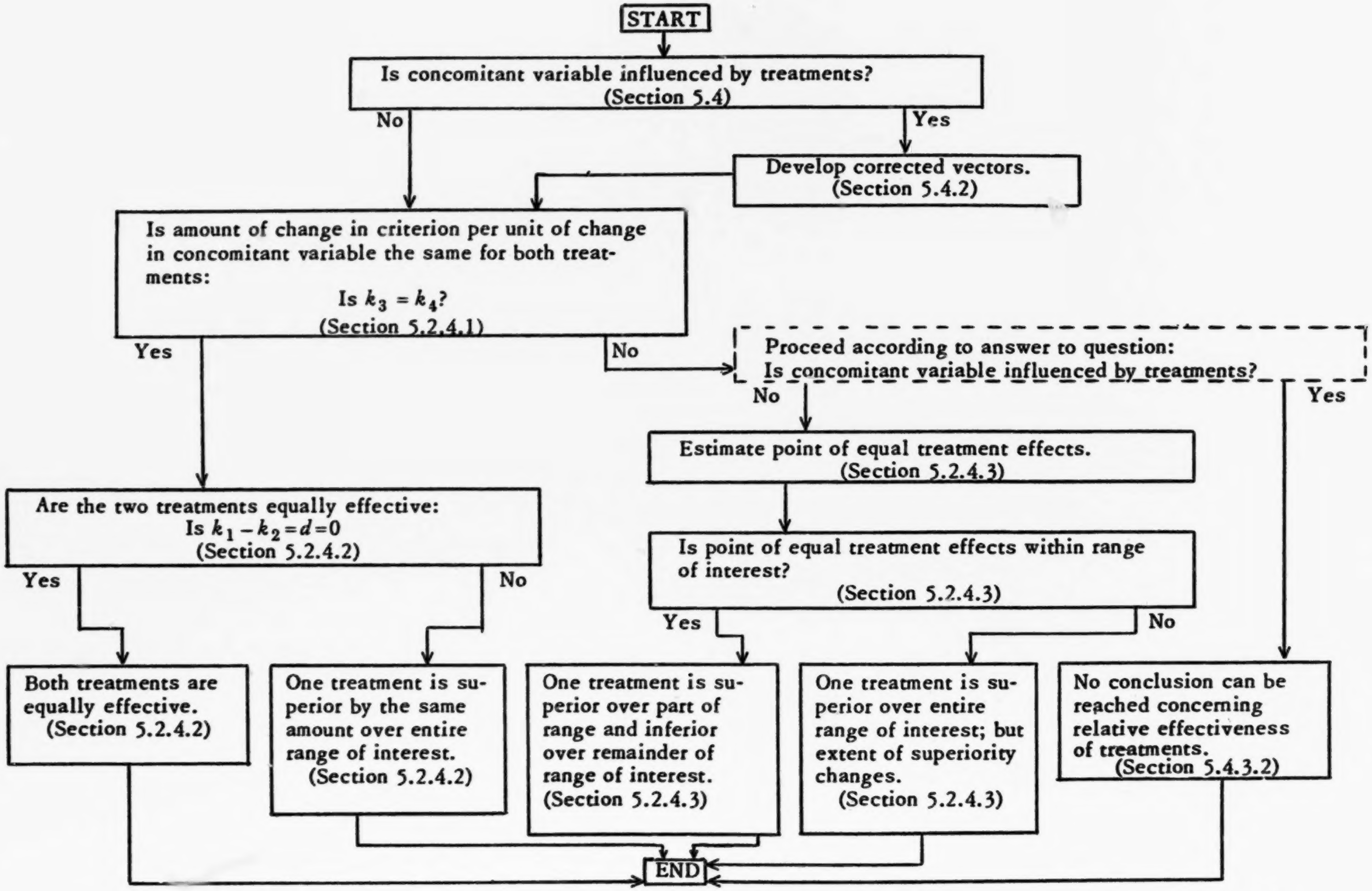
START
Is concomitant variable influenced by treatments? (Section 5.4)
No
Yes
Develop corrected vectors. (Section 5.4.2)
Is amount of change in criterion per unit of change in concomitant variable the same for both treatments: Is $k_3 = k_4$? (Section 5.2.4.1)
Yes
No
Proceed according to answer to question: Is concomitant variable influenced by treatments?
No
Yes
Estimate point of equal treatment effects. (Section 5.2.4.3)
Are the two treatments equally effective: Is $k_1 - k_2 = d = 0$ (Section 5.2.4.2)
Is point of equal treatment effects within range of interest? (Section 5.2.4.3)
Yes
No
Yes
No
Both treatments are equally effective. (Section 5.2.4.2)
One treatment is superior by the same amount over entire range of interest. (Section 5.2.4.2)
One treatment is superior over part of range and inferior over remainder of range of interest. (Section 5.2.4.3)
One treatment is superior over entire range of interest; but extent of superiority changes. (Section 5.2.4.3)
No conclusion can be reached concerning relative effectiveness of treatments. (Section 5.4.3.2)
END

Fig. 4. **Flowchart showing sequence of steps necessary for comparing effects of two treatments when a concomitant variable may be operative.**

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RETRIEVAL TERMS

race
Negro
Caucasian
social dialect
speech
listening
perception
rating
self-rating
acoustic
speech spectography
socioeconomic status
psychoacoustics
psychophysics
integration
communication
education
socio-linguistics
ethnolinguistics
phonological analysis
stereotypic reaction

IDENTIFIERS: Articulatory Product Score (AP); Kay Sona-Graph Model 6061-A

ABSTRACT

The purpose of this study was to specify variables which function significantly in the racial identification and speech quality rating of Negro and white speakers by Negro and white listeners. An additional purpose was to specify any significant differences in vocal resonance characteristics between a group of male speakers most often identified by listeners as being Negro and a group of male speakers most often identified as being white. Distribution of socioeconomic status scores within the sample was representative of the distribution of such scores in Southern U.S.

Listeners were asked to identify the race of each speaker and make a speech quality rating of recorded samples. The Articulatory Product (AP) score developed by Guttman was used as an independent, semi-objective index of speech proficiency. Resonance characteristics were studied through analysis of spectrographic displays of the [i] and [u] vowels.

Results: (1) Number of phonetic distortions by speakers predicts racial identification by listeners; (2) Socioeconomic status score and Articulatory Product score predict speech quality rating of speakers by listeners; (3) No significant intergroup differences were found on spectrographic variables. Negro speakers used in acoustic analysis, however, had consistently greater attenuation of formant amplitudes of the [u] vowel than white speakers.